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China Report

SCIENCE AND TECHNOLOGY

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CHINA REPORT

SCIENCE AND TECHNOLOGY

CONTENTS

PEOPLE'S REPUBLIC OF CHINA

Briefs
       More Drug Inspectors Urged   61

PUBLICATIONS

       Titles of Selected Papers From the Sixth National Conference on
          Infrared Science and Technology
             (HONGWAI YANJIU, No 2, Apr 85............................. 62

                              ABSTRACTS

CHEMISTRY

COMPUTER APPLICATIONS

CRYOGENICS

ELECTRONICS

ENGINEERING

LASERS

APPLIED SCIENCES

PROGRESS OF INERTIAL CONFINEMENT RESEARCH DETAILED

[Article by Wang Ganchang [3769 3227 2490] of the Institute of Atomic Energy;
manuscript received 31 Aug 84]

[Text] Abstract

In this article we briefly describe the recent progress of inertial confinement
fusion (ICF) research. Four topics considered to be the most important at the
present time are selected for discussion. These are the "cannonball" target,
the high power krypton fluoride (KrF) laser, the ion beam diode, and the
imploding foil plasma.

The principle of the cannonball target and its advantages over ordinary ablation
targets are given. It is particularly significant that Japanese researchers
have obtained the highest neutron yield to date (4×10^{10} per pulse) using
cannonball targets. The important problem of hole sealing of cannonball targets
is also discussed.

The powerful KrF excimer lasers pumped by electron beams are discussed next.
This type of laser is now generally regarded as one of the more promising
drivers for ICF. Here we briefly describe the complex kinetics of pumping,
quenching, radiation, and absorption of this very interesting laser. A com-
pression of the KrF laser pulse length from about 100 nanoseconds to a few
nanoseconds is required for ICF work. We describe three of the compression
methods, namely, pulse splitting and stacking, Raman back-scattering, and a
combination of the two.

For the third topic we discuss the present status of ion beam production,
especially the diodes which produce the ion beams. Three types of diodes
are discussed: the pinch reflex diode (PRD), the diode with an externally
applied magnetic field, and the hybrid amphion diode. New results of the
Reiden-IV studied by the Institute of Laser Engineering, Osaka and by Etigol
in Nagaoka Technical University, Nagaoka are also reported.

Finally we discuss the imploding foil plasma. This technique produces plasmas
of very high temperature and very intense soft X-rays which may either be used
to produce an X-ray laser or as a new driver for ICF.

I. The Cannonball Target

The short-term goal of inertial confinement is ignition. Ignition is the
spontaneous burning of the deuterium and tritium gas mixture in the target
(not necessarily a sphere) when the gas reaches a sufficient density under the
compression action of the driver which may be laser beams, particle beams or
other beams. The key is the most efficient absorption of the driving energy
and the maximum compression. In the common ablation compression scheme, the
inward compression is produced by the reaction of the outward ablation of the
high temperature plasma from the target surface caused by the driving beam.
Obviously the energy utilization rate of this type of compression is relatively
poor and part of the incident energy will be reflected back. A scheme based
on the hohlraum principle was therefore proposed to improve the utilization rate
of the incident light energy. The working principle is illustrated in Figure 1.
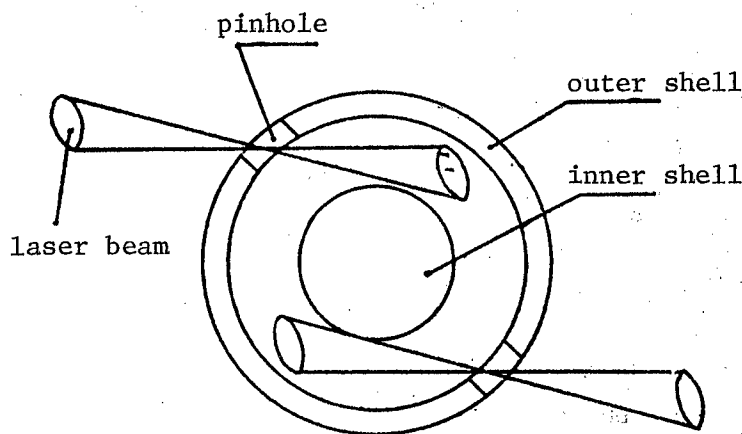
Fig. 1   The Hohlraum Target

In Figure 1, the diameter of the outer shall is 400-500 μm, the walls thickness
is 4-6 μm, and the diameter of the pinhole is 40-100 μm. The incident laser
is focused on the pinhole with lenses and almost all the light enters the target
and is eventually absorbed. It has been said that the Japanese first proposed
this type of target[3] but it has also been claimed that the Americans conducted
such experiments in the early 1970's as unpublished classified research. In
any case, the Institute of Laser Engineering (ILE) of Osaka University, led by
Professor Chiyoe Yamanaka, achieved the highest neutron yield of 4×10^{10} per
pulse in laser inertial confinement using the hohlraum target (the Japanese
call it the cannonball target) in late 1983. What allowed the Japanese to
achieve the highest neutron yield in the world was their novel target design
and the large laser energy and power available to them. The Japanese laser
facility is given the name Gekko XII, which is the largest laser of ILE and also
the largest in the world at the present time. The Gekko XII facility was
completed at the end of 1983, and is being continuously improved and upgraded.

Table 1 shows all the lasers at ILE currently under operation. It shows that the Japanese are engaged in various basic research experiments in addition to target shooting with high-power lasers. They are part of the "King Kong Project" whose goal is the breakeven of the inertial confinement fusion. They expect to achieve this goal in 1987 with a total laser energy of 100 kJ, possibly from an upgraded Gekko XII.

Table 1. Lasers at the Institute of Laser Engineering

System	Material	Wavelength (μm)	Beam number	Total energy (kJ)
Gekko II	Glass	0.355	2	0.3
Gekko IIM	Glass	1.05	2	1.6
Gekko IV	Glass	0.526	4	0.6
Gekko XII	Glass	1.05	12	20.0
Lekko II	CO_2	10.6	2	1
Lekko VIII	CO_2	10.6	8	10

We shall now elaborate on the hohlraum target.

1. Principle of the hohlraum target

The ball of the hohlraum target (referred to by the Japanese as the cannonball target) is the inner sphere containing the DT mixture. It works as follows[4]: when the laser passes through the pinhole, it is first absorbed by the inner surface of the outer shell and high temperature plasma and X-rays are produced and the space between the outer shell and the inner sphere is filled with plasma. The plasma becomes shock waves and reflection waves bounding between the two surfaces, which continuously compresses the inner sphere and raises its temperature. This is quite different from the previous ablative method.[1,2] The hohlraum method is like a cannon and the ablation method is like a rocket. The former has a high efficiency and the latter has a low efficiency.

In addition to the efficient utilization of the laser energy, the cannonball target has another advantage, the surface finish and the uniformity requirements of the inner sphere are not as stringent as that of the ablative target. In the cannonball target, the X-ray and plasma shock waves produced by the laser undergo multiple reflections between the two surfaces of the cavity and result in very uniform compression. For the ablative target the compression is driven directly by the laser beams and can easily be nonuniform.

2. In the cannonball target (see Figure 1), the properties of the X-ray and plasma produced by the laser are determined by the properties of the inner surface of the outer shell. If the inner surface is made of a light material such as plastic or beryllium, the product is mainly a hot plasma converging toward the center of the target. If the inner surface is made of a heavy

material such as gold or tungsten, a great amount of soft X-rays (with an energy less than 1 keV) and plasma will be produced. The X-rays make multiple bounces in the cavity and homogenizes the space, thereby creating highly favorable conditions for centripetal compression. This is a very important effect and the final success of laser inertial confinement may rely on it.

The compression and heating of the inner sphere can also be enhanced by surrounding it with a light metallic foam. The foam may serve as new hot points for producing X-rays and greatly increase the X-ray intensity in the cavity and hence the compression.

3. The Institute of Laser Engineering of Osaka University is currently conducting a number of basic research on the energy injection coefficient η_E of the hohlraum target, the X-ray conversion coefficient η_x, the pinhole closing time t_c, and the cavity absorption coefficient η_a. The work on hole sealing and closing time tc is particularly significant and may influence the success of the hohlraum target experiment. The magnitude of t_c depends on the size of the hole, the target material, the wall thickness of the outer shell and the width of the laser pulse. The relationship must be understood before any formal experiment can be done. Researchers at Osaka University have bombarded targets with 0.1-1.0 ns laser pulses. Using the HIMICO code, they have computed the energy injection rate $\eta_e = \dfrac{E_{LC}}{E_{LT}}$, where E_{LC} is the laser energy entering the empty cavity and E_{LT} is the total incident laser energy. As a matter of fact, they have studied the transmissivity or injection rate of a 100 μm hole and found t_c to be generally in the 400-500 ps range. Pulses of 2-3 ns duration are evidently too long and a good deal of energy cannot enter the hole.[5] These are, however, only preliminary results and more detailed results are expected.

4. One study that deserves our attention and continued research effort is the cannonball experiment using the Lekko VIII CO_2 laser conducted by Professor Sadao Nakai at the Institute of Laser Engineering. He found that a CO_2 laser at a wavelength of 10.6 μm also did very well on the cannonball target without the troublesome super-heated electrons produced by the ablative target. They found that the X-ray temperature produced by the laser energy in the target cavity may reach 30 keV. They are currently continuing the study of this very interesting problem.

Overall, the application of the cannonball target is indeed a promising new development in the research of laser fusion. No wonder people felt that although laser fusion has encountered some difficulties recently, the fabfication of the new cannonball target and some new theoretical interpretation have raised hope of success in laser fusion.[6]

II. KrF* Laser and Its Applications

2.1 General description of the KrF laser

Up to now lasers used in inertial confinement fusion are mostly neodymium glass lasers and only a few CO_2 gas lasers. The glass lasers are solid state lasers with a low efficiency (about 0.1 percent), the thermal conductivity is low,

the wavelength of 1.06 μ m is somewhat too large and the cost is high. The CO_2 gas lasers have a higher efficiency (may reach 30 percent) but the wavelength of 10.6 μ m is too large. Neither one is ideal as a driver for inertial confinement. Efforts are made to find a more suitable laser for inertial confinement and the most promising laser to date is the KrF* laser. It is one of the excimer lasers and has a wavelength of 0.248 μ m. Of the excimer lasers, the KrF* laser has the highest optical efficiency, its overall efficiency is close to 5 percent and it is more suitable for inertial confinement because it is a gas laser and has a high repetition rate.

There are two major excitation methods in the KrF* laser: rapid discharge excitation and pulsed electron beam excitation. When the desired laser power is not great, rapid discharge pumping may be used. KrF* lasers used in inertial confinement fusion are pumped with a pulsed electron beam. Figure 2 shows schematically the transverse pumping method,[1,2] the most commonly used method for producing pulsed electron beams. The electron beam produced by such a device is often pinched by its own magnetic field. An externally applied axial magnetic field may be used to produce a more uniform electron beam distribution in a certain range. The electron energy is generally in the 200-2000 keV range.
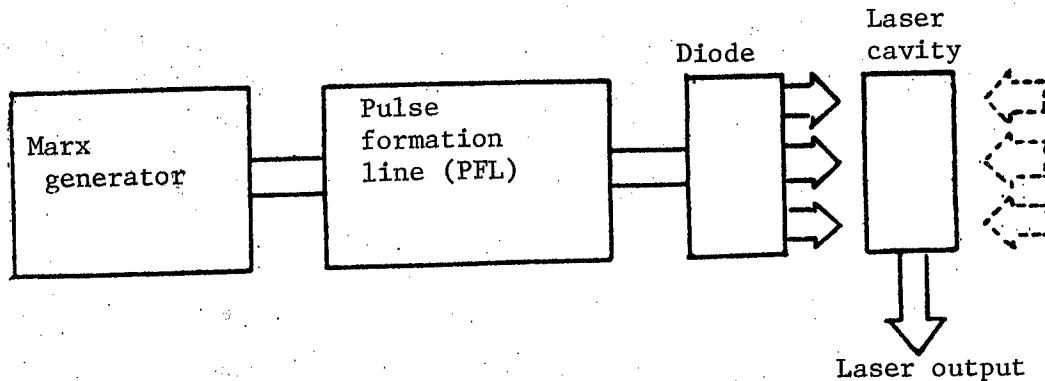
Fig. 2 Schematic Diagram Showing the Transverse Pumping by a Pulsed Electron Beam

The electron beams may be injected from the left side and from the right side to give a more uniform absorption of the electrons in the gas cell (also the laser cavity). The electron current density should be in the 50-200 A/cm^2 range. The composition of the gas in the cell (cavity) is Ar:Kr:F = 1000:100:4. The total pressure is between 1 and 3 atmospheres. The container must have a thin film window made of Ti, Al or stainless steel so that the electron beam may penetrate the wall without suffering a great loss in energy.

2.2 Experimental research of KrF* lasers

When KrF* lasers first came out in 1976 their pulse energy was in the 100 mJ range, but there have been rapid developments in recent years. In 1983 the "Sprite" laser built by the Rutherford Institute in the United Kingdom had an output pulse energy of 200 J and a pulse width of 40 ns. In June 1983 a new

excimer KrF* laser at Los Alamos began running at a pulse width of 500 ns and
an output energy of 20 kJ. Although its pulse width is too large for laser
fusion work, its development time was only 15 months at a cost of only
\$US1 million.[7] Today, 50 kJ KrF* lasers are said to be in the design stage.

2.3 Kenetic process of the KrF* laser

The strong current electron beam ionizes and excited the atoms and molecules
in a gas mixture of Ar, Kr, and F_2. The interaction of the ionized and excited
particles produces the KrF* excimer and under certain conditions emits a laser
light via resonance.

In order to estimate the output energy, output power, and efficiency of the laser,
we must investigate the kenetics of the KrF* laser. Such processes are very
complex and we shall only consider five related aspects:

1. Formation of KrF* excimers

The KrF* excimers generally do not form under low pressure. Stable diatomic
ground state molecules such as KrF are difficult to form in an inert gas and
halide gas mixture (such as Ar, Kr, Xe and F_2, Cl_2 systems). Therefore,
excimers such as KrF* cannot be obtained from the ground state molecules by
direct pumping. They must be formed from an excited atom and other atoms
when radiated. To obtain the desired (AB)* excited molecule, the following
reaction must be used:

$$A^* + B + C \longrightarrow (AB)^* + C$$

This is a three-body reaction. The presence of the third body C is necessary
for satisfying momentum and energy conservation. In practice the third body
is usually one of the atom species in the reaction. The probability for the
three body interaction is usually small and the reaction must take place under
a high pressure so that atomic collisions are frequent.

At present our interest is the production of the KrF* excimer by pumping the
Ar:Kr:F_2 gaseous mixture (with a partial pressure ratio of 1000:100:4) with
an electron beam. There are several reaction channels, we shall discuss the
two principal ones.

The first reaction is

$$Ar + e_t \longrightarrow Ar^+ + e_t + e_s \tag{1}$$

$$F_2 + e_s \longrightarrow F + F^- \tag{2}$$

$$Ar^+ + F^- + (M) \longrightarrow ArF^* + (M) \tag{3}$$
$$(M \text{ may be Ar or Kr})$$

$$ArF^* + Kr \longrightarrow KrF^* + Ar \tag{4}$$

6

For reaction (1), we have

$$S_{Ar^+} = \frac{j \times n_{Ar} \times \sigma(e_f, Ar^+)}{q_e}$$

where S_{Ar} is the Ar + rate of generation in $1/cm^3$. s,

 j is the electron beam current density A/cm^2,

 n_{Ar} is the number density of Ar in $1/cm^3$,

 q_e is the electron charge (C),

 e_f is the fast electron,

 e_s is the slow electron,

and σ (e_f, Ar^+) is the cross-section (in cm^2) for producing Ar^+ in the interaction between the fast electron and the Ar atom.

For reaction (2), we have

$$S_{F^-} = K e_{s F2} \, [e_s] \cdot [F_2]$$

where S_F – is the rate of generation of F_ in $1/cm^3$ s, $[e_s]$ is the number density of slow electrons in cm^{-3}, $[F_2]$ is the number density of F_2 molecules in cm^{-3}, and $K_{e_s}F_2$ is the rate coefficient of reaction (2) in cm^3/s.

For reaction (3), we have

$$\frac{d[ArF^*]}{dt} = K_{Ar^+, F^-}[Ar^+][F^-] - K_{ArF^*, K}[ArF^*][Kr]$$

and

$$\frac{d[Ar^+]}{dt} = S_{Ar^+} - K_{Ar^+, F^-}[Ar^+][F^-]$$

For reaction (4), we have

$$\frac{d[KrF^*]}{dt} = K_{ArF^*, Kr}[ArF^*][Kr]$$

The second channel of reaction is

$$Ar + e_f \longrightarrow Ar^+ + e_f + e_s$$
$$Kr + e_f \longrightarrow Kr^+ + e_f + e_s$$
$$F_2 + e_s \longrightarrow F^- + F$$
$$Ar^+ + Ar + Ar \longrightarrow Ar_2^+ + Ar$$
$$Ar_2^+ + Kr \longrightarrow Kr^+ + 2Ar$$
$$Kr^+ + F^- + Ar \longrightarrow KrF^* + Ar$$
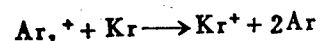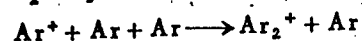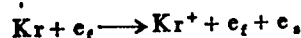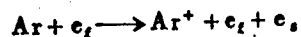
As in the above, we have

$$S_{Ar^+} = \frac{j \times \eta_{A_r} \times \sigma(e_f, Ar^+)}{q_e}$$

$$S_{F^-} = K_{e_f, F_2}[e_e][F_2]$$

$$\frac{d[Ar_2^+]}{dt} = K_{Ar^+, \cdot \cdot r}{}^2[Ar^+][Ar^2] - K_{A_{r2}^+, \kappa_r}[Ar_2^+][Kr]$$

$$\frac{d[Kr^+]}{dt} = S_{Kr^+} - K_{Kr^+, F^-}[Kr^+][F^-] + K_{A_{r2}^+, \kappa_r}[Ar_2^+][Kr]$$

and other reactions may be neglected.

2. Quenching of KrF^* excimers

There are two principal quenching processes. Constituent molecules in the gas may collide with KrF^* excimers and cause dissociation. For example,

$$Ar + KrF^* \longrightarrow Kr + Ar + F$$
$$Ar + Ar + KrF^* \longrightarrow ArKrF^* + Ar$$
$$Ar + Kr + KrF^* \longrightarrow Kr_2F^* + Ar$$
$$F_2 + KrF^* \longrightarrow Kr + F + F_2$$
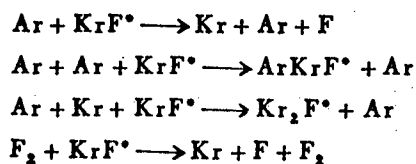
Since the concentration of KrF^* may reach a kinetic equilibrium, this type of quenching process is saturable. The other type of quenching is caused by the formation of intermediate species from gas molecules and KrF^* and thereby interrupts the reaction. This type of quenching has no saturation. For example

$$ArF^* + Ar + Ar \longrightarrow Ar_2F^* + Ar$$
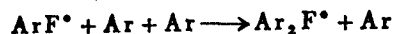
We can also write the differential equations for the reaction in a similar manner.

3. Radiation of the KrF^* excimer

The lifetime τ_{KrF^*} is very short, about 6 ns, and spontaneous radiative transition takes place quickly. The transition probability is

$$A = \frac{1}{\tau_{KrF^*}}$$

KrF^* may also undergo stimulated emission by the incident light and the cross-section is σ_{st}.

8

4. Absorption by the gas medium

The radiation is mainly absorbed by F^-, F_2 and Ar_2^+ and the corresponding absorption cross-sections are σ_{F^-}, σ_{F_2}, and $\sigma_{Ar_2^+}$. The number of photons per unit volume in the cavity is given by

$$\frac{d[h\nu]_{in}}{dt} = \frac{1}{C}\frac{dI}{dt} = \sigma_{s,l}I[KrF^*] + \frac{1}{\tau_{KrF}}[KrF^*]$$

$$- \sigma_{F^-}I[F^-] - \sigma_{F_2}I[F_2] - \sigma_{Ar_2}^+I[Ar_2^+]$$

where $[h\nu]_{in}$ is the number of photons per unit volume, and I is the number of photons passing through a unit area in a unit time along the normal direction of the mirror in the cavity.

5. Laser output from the cavity

It is well known that an initial laser intensity I_0 in the cavity becomes $I = I_0 e^{\gamma_0 L}$ after a length L. From the derivation above, we have

$$\frac{d[h\nu]_{in}}{dt} = \gamma_0 L$$

where γ_0 is the net gain of the laser after absorptive losses. It can be shown that when $\gamma_0 = -\frac{\ln T^2 R}{2L}$ the laser is operating at the threshold and begins to have a gain. Here $T = t_1 t_2$ is the product of the transmissivity of the two windows and $R = r_1 r_2$ is the product of the reflectivity of the two cavity mirrors. The total output of the laser is

$$E_{laser} = \int\int \frac{d[h\nu]_{in}}{dt}dtdV = \int\int \gamma_0 I dt dV = \int\int \left(-\frac{\ln T^2 R}{2L}\right) I dt dV$$

In essence we can write down a simultaneous equation describing the entire kinetic process of the formation of the KrF* laser, the quenching, radiation, absorption, and output of the laser and solve for the parameters of interest. Due to the limitation of space, the details will not be given here.

2.4 Compression of the KrF* laser pulse

The advantages of the KrF* laser are: the wavelength is in the infrared region, the light emitting efficiency is high, the medium is a gas and the heat dissipation is easy. But it has one drawback: its pulse width is large, from several tens to several hundred nanoseconds. This drawback is detrimental to the efficiency.

9

In order to eliminate this drawback, three methods have been employed so far to achieve pulse compression: the pulse stacking method, the Raman backscatter method, and a combination of the two methods above.

1. The pulse stacking method

The principle of the pulse stacking method is shown in Figure 3.
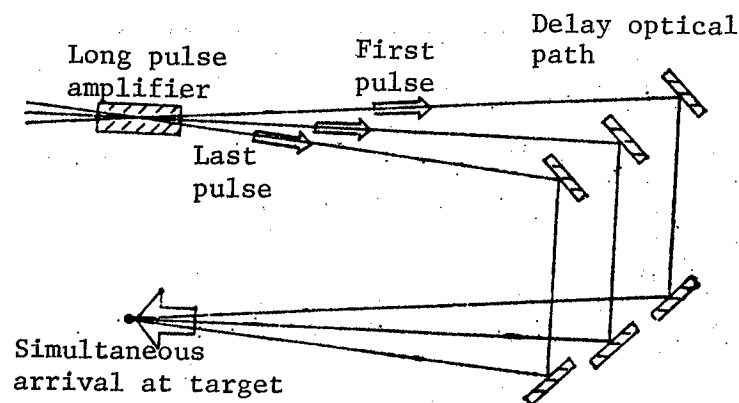
Fig. 3 Schematic Diagram Showing Simple Pulse Stacking

Temporally and spatially separated multiple pulses are produced by passing a long KrF^* laser pulse through a multibeam generator which has beam splitters and reflection mirrors. Incident pulses at various angles go through properly prescribed optical path and reflection and arrive at the target simultaneously, achieving the stacking of multiple pulses.

Using the multibeam generator, one pulse is split into N temporally and spatially separated pulses. The amplifier and the stacker accomplish the pulse compression and power amplification. However, N cannot be too large since difficulties are encountered when N is greater than 4 or 5. On the one hand the number of optical components becomes great and on the other land long propogation distances will be required to separate the beams temporally and spatially.

2. The pulse compressor

The pulse compressor is actually a Raman amplifier which converts a long pulse into a short pulse using the principle of Raman backscattering and achieves power amplification. The action of a pulse compressor is shown in Figure 4. A KrF^* laser pulse of width τ_p and frequency ν_p passes from right to left through a gas cell containing CH_4 gas as the Raman medium. The CH_4 molecules are excited and Raman scattering takes place. This pulse is known as the pump pulse.

Let the transition frequency of the stimulated Raman medium be V_r. When the pumping pulse propagates to the end of the Raman cell, a short pulse is injected from left to right. The short pulse is emitted from another Raman cell and is called the Stokes pulse. The frequency of the Stokes pulse V_s satisfied the condition $V_s = V_p - V_r$. Due to stimulated Raman scattering, the Stokes pulse is amplified and the energy of the pumping pulse is dissipated in the Raman medium. The length of the Raman cell is made to be equal to the propagation distance of light in the time interval $\tau_p/2$. At $t = \tau_p/2$, the trailing edge of the pumping pulse meets the leading edge of the amplified Stokes pulse at the right-hand end of the Raman cell. In this arrangement the Stokes pulse is continuously amplified along the entire length of the Raman cell while maintaining the same pulse width. If the compression ratio of the Raman amplifier is K and the extraction efficiency is η_R, then the power gain after Raman amplification is $P/P_0 = K \eta_R$. Generally $K \simeq 10$ and $\eta_R \simeq 50$ percent, P/P_0 is therefore about 5.
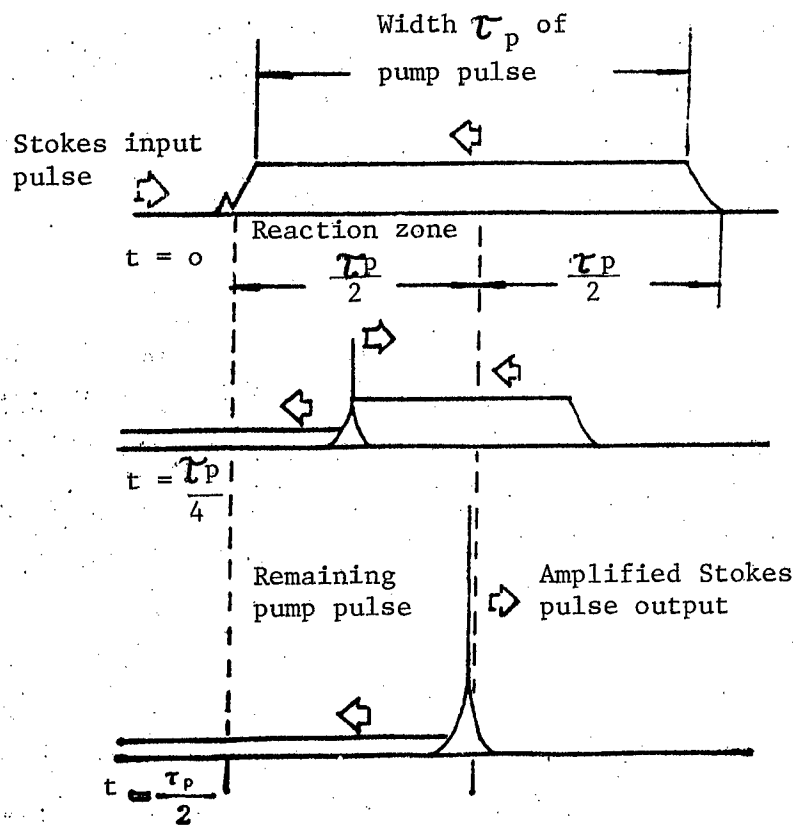

Fig. 4 Raman Scattering Stacking

3. Combination of stacking and compression

The configuration of this method may take various forms. Figure 5 shows a simple arrangement.
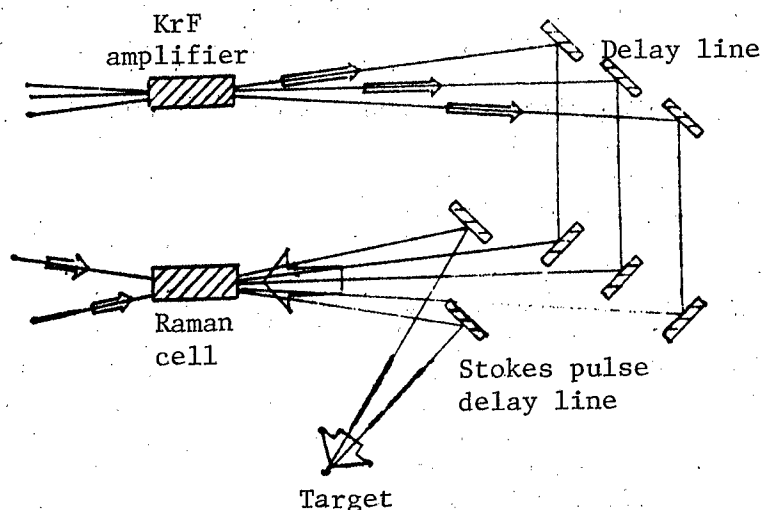
Fig. 5 Raman Scattering and Pulse Stacking Combination

Several long KrF* pulses (Figure 3 has three pulses) are amplified and go through different optical paths. After pulse stacking, they are directed to the Raman amplifier. One or two pulses enter the Raman cell from the opposite direction and produce an amplified pulse at the exit of the cell. After going through different optical paths, the pulses are stacked on the target. Using this method, it should not be difficult to compress a 60 ns 248 nm KrF* pulse to a 5 ns 268 nm Stokes pulse with 10 times the power. The Rutherford Institute in the United Kingdom is currently conducting the design to compress a 60 ns 300 J KrF* pulse to a 1 ns pulse and raise the power density from

6×10^{13} W/cm^2 to $10^{14} \longrightarrow 10^{15} \longrightarrow 10^{16}$ W/cm^2.

As discussed above, the KrF* laser is a promising candidate for a high power source. There are no more insurmountable difficulties and the estimated cost is about one order of magnitude lower than that of Nd:glass laser. The prospects are good, but it is still hard to predict whether major difficulties will be encountered in building extremely high energy KrF* lasers in the 100 kJ or MJ range.

III. Light Ion Beam Fusion Research

Light ion beam as fusion drivers have the advantages of high efficiency ($\gtrsim$ 30 percent), low cost ($\lesssim$ \$50/J), relatively simple energy deposit behavior on the target and in agreement with classical theoretical computation, and produce no preheating of the thermonuclear material at the center of the target by superheated electrons. The main difficulties of using light ion beams are the transport and focus of the beam, especially the latter. The efforts in

12

recent years are mostly concentrated on the temporal compression of the pulse power for a shorter pulse and higher peak power. The reduction of the spot size is achieved through improved beam intensity, suppressed divergence angle, and improved particle beam energy per unit area on the target surface.

The quality of a light ion beam is determined mainly by the beam brightness. The beam brightness is given by   where J is the current density

of the beam, V is the voltage between the cathode and the anode, and $\Delta\theta$ is the vertical or horizontal microscopic divergence angle when the ions are emitted from the anode. The brightness may be increased by raising the voltage V (i.e., increasing the ion energy) and increasing the current density. To reach ignition, B must in general exceed 10^{14} W.cm^2.rad^2.

The pinch reflex diode (PRD) of the Naval Research Laboratory in the United States has a current density of 3-30 kA/cm^3. The diode with an external magnetic field at Sandia Laboratory[10] has a current density of 7-35 kA/cm^3. In both facilities it was observed that no apparent relationship exists between $\Delta\theta$ and J. The dependence of the brightness on the current density is basically a linear relationship. The dependence of the brightness on the voltage V is of particular interest because $\Delta\theta$ decreases as V increases. Based on limited available data so far, B depends on V^2, as shown in Figure 6.

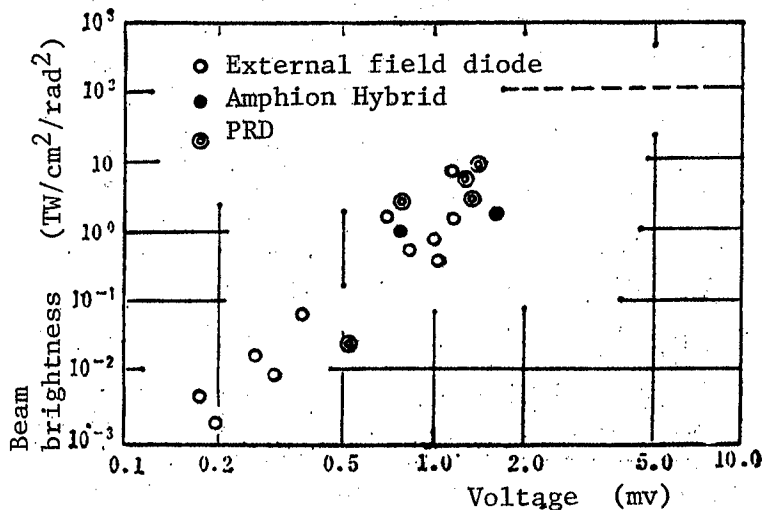Fig. 6   Dependence of Beam Brightness on Voltage for Three Different Diodes

The vertical or horizontal microscopic divergence angle $\Delta\theta$ is determined principally by:

1. Deflection of the ion beam in the nonmagnetic neutral zone.

2. The filament instability when the ion beam passes through the gap between the cathode and the anode increases the divergence angle, which in turn affects the beam intensity.

3. Instability caused by the interaction between the ion beam and the cathode plasma when the beam passes through the electron cloud and effects of the background gas.

4. Nonuniformity of the anode plasma. The surface smoothness and homogeneity of the anode plasma directly affect the size of $\Delta\Theta$.

In essence, the light ion beam driver must have the following characteristics: (1) a large accelerating voltage, (2) a high current density, (3) a large magnetic field in the accelerating gap, (4) a magnetically neutral beam transport, (5) a beam of light ions such as Li^{+2} or C^{+2} but not protons.

To improve the ion beam, Sandia Laboratory, the Naval Research Laboratory (NRL) and Cornell University[1] in the United States have each worked on one type of ion beam diode and the best one was used in PBFA-II. The ion beam diodes are respectively the PRD developed by NRL, the external field diode developed by Cornell and the Amphion-hybrid automatic injection plasma diode developed by Sandia Laboratory.

Japan started its research in the ion beam area later than the United States but has had rapid development. The Reiden VI at Osaka University has now been upgraded to Reiden VI-H, the output voltage has been increased from 1.7 MV to 3M and, like the Americans, the Japanese have also used the plasma erosion opening switch (POES) and achieved 1.5 times power amplification and 1 percent prepulse. They are also working on ion gun improvements, hoping to have a 4 times power amplification. The ETIGO-I at the Nagaoka Industrial University has a voltage of 1.5 MV and a current of 200 kA. The ETIGO-II is being actively developed to raise the voltage to 3 MV and the current to 300 kA. They have developed a medium mass atomic linear induction accelerator system (MALIA) to accelerate medium ions such as B^{+}, C^{+} and Ne^{+}. Spontaneous focusing by the particle trajectory may eliminate the plasma channel and other complicated setup. The parameters of the medium mass ion beam are 420 kV, 6 kA, and 5 ns. This is of course a small prototype, but it is a good start.

The Japanese researchers have also worked extensively on the ion beam diode and their newest achievement is the inverse pinch diode (IPD). The improved model IPD has a small divergence angle $\Delta\Theta$ and has reached a beam brightness of 4.3 $TW/cm^2 \cdot rad^2$ with a uniformity of 40 percent.

IV. Implosion Plasma Research

The research on implosion plasma began in the early 1970's. It did not receive much attention in the beginning but has attracted great attention recently. This research became even more significant along with the development of high power pulse accelerators. One of its possible applications is the inertial confinement. We now briefly describe the implosion process.

The mechanism of implosion has been reported in the literature.[11] A 2-3 cm long, a few centimeter radius metal foil cylinder, metal wire array or cylindrical shell is placed between the electrodes of a high-power accelerator as a load. A prepulse is first applied to cause ionization and then, under action of the main pulse, the great JxB centripetal force (J is the current and B is the self-generated magnetic field) leads to implosion.

Today there are at least six places in the United States that are conducting implosion research. France and Canada are also working on implosion research but on a smaller scale. Among the U.S. companies, Maxwell and Physical International (PI) produced the most prominent results. Table 2 lists the experimental parameters[12] of a typical test on the Blackjack-5 of the Maxwell Company. As can be seen, the plasma temperature has reached 1-2 keV and the electron density has reached $10^{21}/cm^3$ at a power less than 10 TW. In other experiments people have obtained several tens of kilojoules of X-rays (energy from a few eV to a few keV) and arrived at a method to eliminate the Rayleigh-Taylor instability.

Good results were also obtained on the Pithon facility--a joint effort of PI and LLNL. The high intensity soft and supersoft X-rays (40 eV-13 keV) are most interesting. When the stimulated medium is an argon gas, they obtained the quasi-Ne and quasi-FKr lines in the X-ray region and the vacuum ultra-violet (VUV) radiation emitted by the Kr plasma. Some of the spectral lines yet to be identified are believed to be Ne-like transitions including the expected laser transition. In the AFWL experiment, deuterium was used in the cylindrical jet, although the X-ray obtained was weaker than expected, consider-able number of neutrons were obtained at a temperature of several tens of keV.

Based on the experimental results just described, the implosion plasma may be used as an X-ray laser light source and may also be used in inertial confine-ment. These are undoubtedly the two main reasons for the great amount of money and effort devoted to such research. The advantages are the simple testing procedure and the elimination of complicated and minute targets. More important, the product is of the centimeter length and 0.1 mm diameter. It is large in size and can be operated and handled more easily. Its output energy (5MJ) and power (15 TW) are also great, the energy is 50 times that of the current NOVA laser (100 kJ, 100 TW). Although the power is only 1/7 of that of NOVA, the average power density is $\sim 10^{14}$ W/cm^2, but it produces a great amount of soft X-ray (of the order of 10 kJ). In this respect, it serves better as an X-ray laser source than an inertial confinement source. Since it uses cylindrical compres-sion and not spherical compression, the efficiency is not as good. Under the leadership of Professor (Lu-da-ke-fu) of the Kurchatov Institute in the USSR, there has been a continuous effort on the Angara-V (2 MV, 25 MA) to study implosion methods and strive for important inertial confinement results. Unfortunately, they have yet to release any of their research results and we cannot comment their finding on the advantages and disadvantages of implosion and inertial confinement methods.

In this paper we have briefly described four new and promising approaches to inertial confinement, they are the hohlraum (or cannonball target), also known as indirect driver, the KrF[*] laser, the light ion beam and the implosing confinement. The readers may refer to the paper by Yonas[10] for an overview of the recent advances in inertial confinement. China has not begun its work on any of these four methods, at most some preliminary work on KrF[*] laser has been done. However, China has had a sound basis to embark on these researches.

Table 2. Typical Experimental Parameters of the Maxwell Implosion Test

Expt. conditions and results \ Type of load	6-wire array	Ar gas shell cylinder
Wire diameter (μm)	Al, Ca, Ti, Fe 30 50 20 65	--
Length	3.0	3.0
Ring diameter (cm)	1.5, 2.0 - 2.5, 2.0, 2.0	2.5
Ring thickness (cm)	--	0.5
Loop diameter (m)	4.0	4.0
Mass (μg/cm)	130, 90, 86	332
Voltage (MV)	3	3
Current (MA)	4.6	3-5
FWHM (ns)	$\sim$100	$\sim$100
Power (TW)	10	10
Implosion time	100 ns after main pulse	90 ns after main pulse
Implosion velocity (cm/s)	80 (Fe)	50
T_c (keV)	0.5 - 2	1
Ne	$5\times10^{20}/cm^3$	$10^{21}/cm^3$
K-line zone (FWHM)	1.2 - 3.0 mm	--
K-line pulse (FWHM)	20-25 ns	--

In the area of high power solid laser and gas laser the Shanghai Institute of Optics and Fine Mechanics has had 20 years of experience and an international reputation, they are also experienced in target fabrication. The pulsed high current electron accelerator is the basis for the other three methods, China has built and applied such accelerator for sometime, but the power is not high enough.

China is still a developing country with limited resources, we cannot copy the research approach of the United States, the Soviet Union or Japan. In China we should select the most assuring direction based on what we have and gradually work on higher power. So far there is no "sure-fire" direction. Chinese researchers should watch closely the research trend in other countries and do their best in a careful research based on what is available. Special efforts should be made on theoretical research to understand the physical mechanism more thoroughly and to train new people. Once the direction can be better defined, the preparation work and the national economy are expected to be in better shape by that time, then more money and effort can be devoted to it to produce results.

Inertial confinement fusion research is an interdisplinary, highly technical and difficult frontier science and technology. As research progresses, it would undoubtedly promote other areas of science to achieve new advances in technology and material. The stake is high in inertial confinement, and success will eventually come as long as the scientists continue their effort with perseverance.

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APPLIED SCIENCES

ON-LINE SOFTWARE DEVELOPMENT SYSTEM FOR TRS-80(I)/EG3200

[Article by Li Benren [2621 2609 1804], Gong Ganghua [7895 0474 5478] and Meng
Qi [1322 1142], Shenyang Computer Institute, Chinese Academy of Sciences: "On-
line Development System for TRS-80(I)/EG3200 Software"]

[Text] Abstract: This paper is a brief introduction to the
configuration and development performance of this system.
The operating principles and functions of the parts of the
system will be discussed in detail in four special articles.

Currently, the number of TRS-80(I)/EG3200 microcomputer systems and various
single board computers and single-chip microprocessors in China is very large
and the range of applications is also becoming broader. However, there is a
general lack of techniques for developing these single-board and single-chip
microprocessors.

To resolve the problem of development tools, with the TRS-80(I)/EG3200,
single-board and single-chip microprocessors as our object, we developed an
on-line software development template, programmer and a set of development
software so that the general user can upgrade his own TRS-80(I)/EG3200 micro-
computer and single-board computer inexpensively to an on-line software devel-
opment system, clearly improving the efficiency of software development and
promoting the broad application of microcomputers (especially single-board
computers and single-chip microprocessors).

The on-line software development template, programmer, and development soft-
ware we developed is:

Hardware:

    TRS80(I)-Z80 on-line development template
    TRS80(I)-8080 on-line development template
    TRS80(I)-8085 on-line development template
    TRS80(I)-Z80,8080, 8085 on-line development template
    2716/2732/2764/27128 high-speed EPROM programmer (improving
       programming speed by six-fold)
    8748/8741/8755 single-chip computer programmer (can use the
       Z80 single-board computer to control programming)

Software:

> 8080, 8085, MCS-48, UPI-41 cross-assembly editing language
> DSZ80, DS8080, DS8085 development debugging software
> DEPROM high-speed programming software
> DMUE single-chip microprocessor programming software
> ZMUE single-chip microprocessor (Z80 single-board computer
>   controls programming) programming software

The TRS-80(I)/EG3200 on-line software development system forms of the above templates and software passed appraisal in September 1984 and has gone into small batch production.

As the appraisal conclusion pointed out: "With an inexpensive and practical template, this system connects the popular TRS-80(I) computer or EG3200 micro-computer to a single-board computer and programmer carrying out programming and software debugging of such microprocessors as the Z80, 8080 and 8085 and single-chip microprocessors such as the MCS-48 and UPI-41, expanding the TRS-80(I) or EG3200 into an on-line software development system. System operation is simple. Using it as a tool can improve efficiency of developing application of single-board computers and single-chip microprocessors. Especially in EPROM programmers such as the 2764/27128 using a smart program-ming algorithm it achieved advanced levels for similar products abroad. The programmer for many kinds of single-board computers has resolved an urgent need in scientific research and production in China."

The TRS-80(I)/EG3200 on-line software development system can be used to develop software for debugging Z80, 8080 and 8085 single-board computers and for writing programs for the MCS-48 and UPI-41.

The assembly language and cross-assembly editing language provided by the system can be used to write programs for the Z80, 8080, 8085, MCS-48 and UPI-41. This resolved the problem of writing single-board computer and single-chip microprocessor programs. Except for the instruction system memonics, the syntax and format used in the cross-assembly editing language is identi-cal to the syntax and format used in editing TRS-80(I) assembly language and extremely easy for users to learn and master.

Development debugging software, disk object file oriented, carries out file transmission between the TRS-80(I)/EG3200 and single-board computer, resolving the single-board computer program or data I/O technique, but what is more important, it resolved the program debugging technique on the single-board computer. In addition to the DEBUG function on the TRS-80(I), the debugging functions include six debugging commands that were added, i.e., automatic continuous single-step tracing, jump type instruction tracing, call instruc-tion tracing and interrupt program analog debugging functions, which greatly strengthen the debugging ability of the development software.

In sum, at the assembly language level, it makes use of Z80, 8080, and 8085 single-board computers (or prototypes) completely like a microcomputer system.

The programmer hardware and software took into consideration the problems of reset power drop and powering up or down under program control and guaranteeing the safety of the programming chip. Through a single easy insert/remove socket the high-seed programmer carries out programming of four kinds of compatible chips, 2716-27128, uses an intelligent programming algorithm to increase programming speed by six-fold, which has great significance for being able to greatly shorten the programming time for programming the large capacity 2764/27128 chip. The single-chip programmer (programming can be controlled with a Z80 single-board computer) resolves an urgent need in China's scientific research and production. It carries out programming of five types of compatible chips: 8747, 8749, 8741, 8742 and 8755. The programmer software is disk object file-oriented, it can write a disk object file directly to the EPROM chip, thus resolving the problem of the program floating to the EPROM address space without using the address to replace the real. The single-chip program programmer can use the Z80 single-board computer to control programming. This provides the many users who do not have a TRS-80(I)/EG3200 microcomputer system, but have only a Z80 single-board computer technique for using a Z80 single-board computer to control programming of a single-chip microprocessor. It provides units which use a single-chip microprocessor to develop small-scale control devices, intelligent instruments and computer peripherals, it provides a single-chip microprocessor programming technique geared to a variety of products.

In a situation in which the prices of development systems imported from abroad are very costly and lacking a domestic development system which is geared to a variety of types of microcomputers, the development of the TRS-80(I)/EG3200 on-line software development system solves, very inexpensively and very comprehensively, the problem of a software development technique for the domestically commonly used Z80, 8080, 8085 8-bit microcomputer systems (especially single-board computers) and a programming technique for the MCS-48 and UPI-41. This will promote the development and application of microcomputers (especially single-board computers and single-chip microprocessors) and make user software development much more efficient and thus secure clear benefits.

For a detailed introduction to the relevant system working principles and performance, please refer to these four special articles:

> Single-board Computer Programmer
> High-speed General-purpose EPROM Programmer
> On-line Software Development Debugging System
> Design and Implementation of Software Cross-Development Technology

The first two of the articles have already been published. The latter two will be published in the next issue of this journal. Interested readers should consult the corresponding materials.

APPLIED SCIENCES

HIGH-SPEED GENERAL-PURPOSE EPROM PROGRAMMER

[Article by Li Benren [2621 2609 1804], Gong Ganghua [7895 0474 5478] and Meng
Qi [1322 1142], Shenyang Computer Institute, Chinese Academy of Sciences:
"High-Speed General-Purpose EPROM Programmer"]

[Text] Abstract: This paper introduces the intelligent
programming algorithm and hardware design of a high-speed
general-purpose EPROM programmer. The intelligent pro-
ramming algorithm increases the EPROM programming speed
six-fold over general programming methods. With the
addition of disk object file programming software and a
single easy insert/remove socket, carrying out program
controlled power up/down functions for 2716-27128 chips
provides the user with a new technique for programming
EPROM's.

I. Introduction

With the rapid development of LSI technology, the capacity of EPROM's has
leaped to 256K on a single chip (such as the INTEL 27256). Therefore, the
industrial programming standard of the past of applying a standard 50ms
programming pulse by EPROM byte has been increasingly revealed as imperfect.
For example, the programming time of the INTEL EPROM chip by the above
described programming standard is as illustrated in the following table:

Model	Bytes (K)	Programming time (min)
2716	2	1.75
2732	4	3.5
2764	8	7.0
27128	16	14.0
27256	32	28.0

From the table it can be seen that as the capacity of EPROM's has increased, the programming time has grown linearly. The programming time to program all the cells in the 27256 has grown to more than 28 minutes. Clearly, continuing to use this programming method is unacceptable. Thus, we adopted an intelligent programming algorithm and developed a high-speed general-purpose EPROM programmer.

In addition, in hardware design, insuring the safety and reliability of chip read/write is extremely important. Thus, the chip socket and the pins related to the power supply are entirely powered up and down under program control. The design insures that only during read/write do the chip's power supply pin sockets have appropriate voltages and signals, and at all other times, the pin sockets are grounded or floating empty. Thus the safety of the EPROM chip is assured.

Compared to multiple sockets, programming four kinds of chips using a single easy insert/remove socket, both lowers costs and is easier for the user.

II. Principles of Hardware Structure

Figure 1 shows completely the hardware structure principles of the high-speed general-purpose EPROM programmer.
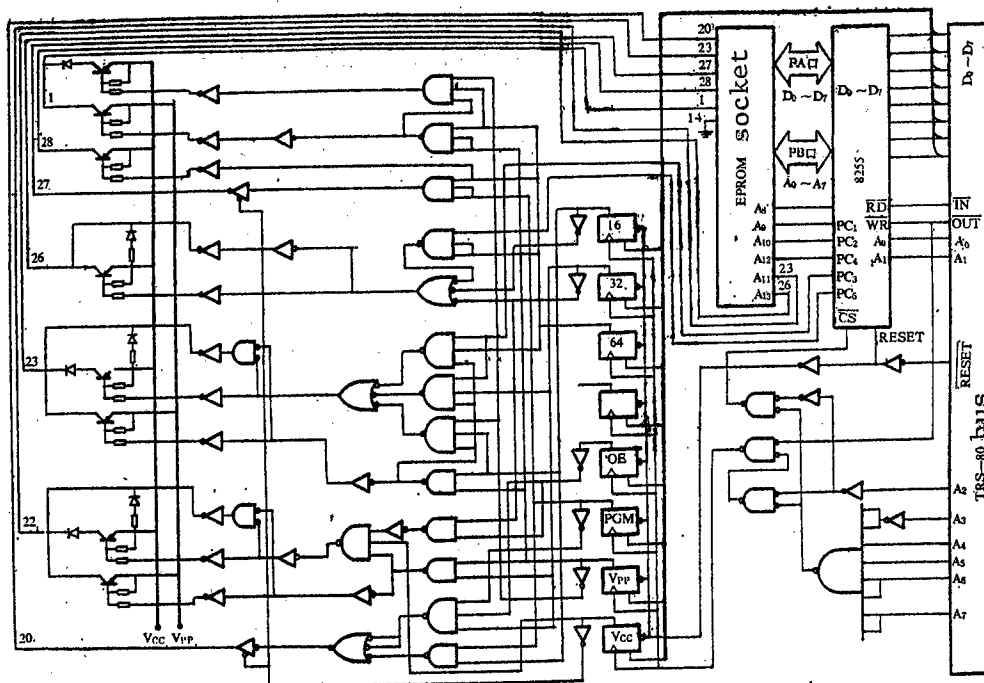

Figure 1. Principles of Programming Hardware Structure

The programmer's external lead connectors are completely compatible with the bus connector leads on the TRS-80(I) microcomputer expansion interface. The Vpp voltage also can be self-adjusted by the user on the basis of EPROM chip demands.

Overall control of the programmer is realized by an 8255 programmable peripheral interface chip and a 74LS273 8-D flip-flop. The 8255's PA kou [0656] works under bidirectional mode and connects with the data line of the EPROM socket; the 14 positions of the PB kou and PC kou are the 16K EPROM space's address lines and address line connections of the EPROM socket (because the 4 types of chips use a single socket in common, some lines must be connected to the EPROM socket after undergoing combination decoding), PC_7 and PC_8 are for use in later expansion. Each position on the 74LS273 is under software control, allowing chip selection and for power up, programming, and readout control.

Because the four types of chips (2716-27128) read and write in the same socket, and their pins are not completely compatible, it is necessary to carry out decoding. The pins of the four types of chips are illustrated in Figure 2: using the ground pin as a reference point, all compatible pins are marked by their names on the EPROM socket. And those pins which are not compatible (or pins which are compatible in name but not in function, such as pin 20) are marked by their names on each type of chip.

The four types of chips share a single socket for read/write, therefore the level relationship of the pins which are not compatible is complex. For example, during read/write of 2716, pin 23 serves as $V_{pp}/+5v$, during read/write of 2732-27128, it serves as A_{11} address line, thus there can be four levels, namely V_{pp}, +5v, logical "1" and logical "0." To simplify circuit design, we considered +5v and logical "1" as equivalents, and designed a special tristate circuit to carry out the work demands of noncompatible pins.
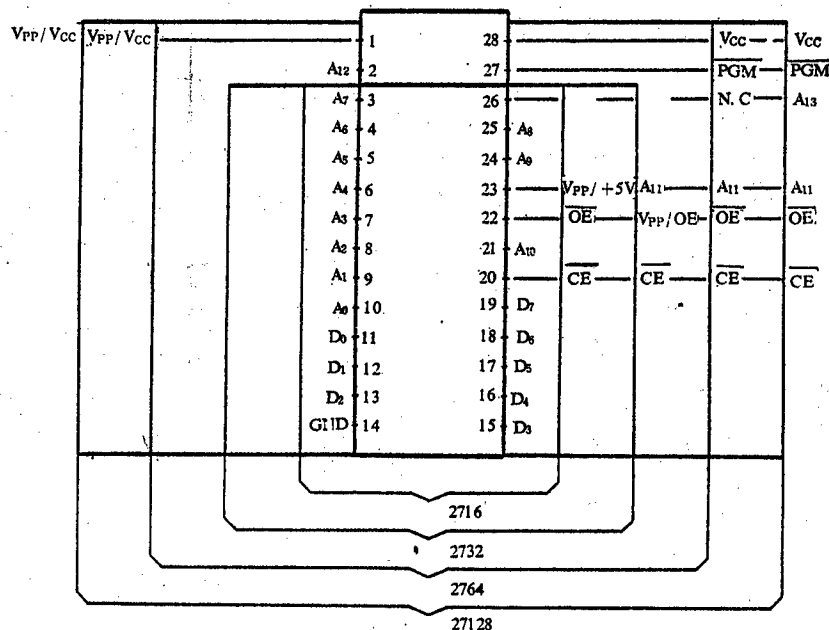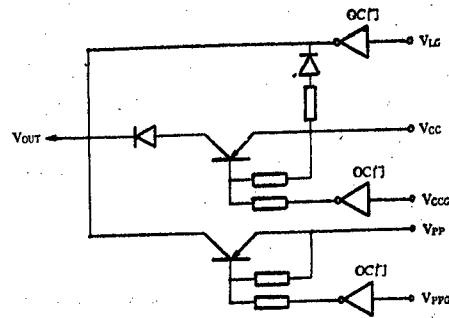

Figure 2. Chip Pin Identification
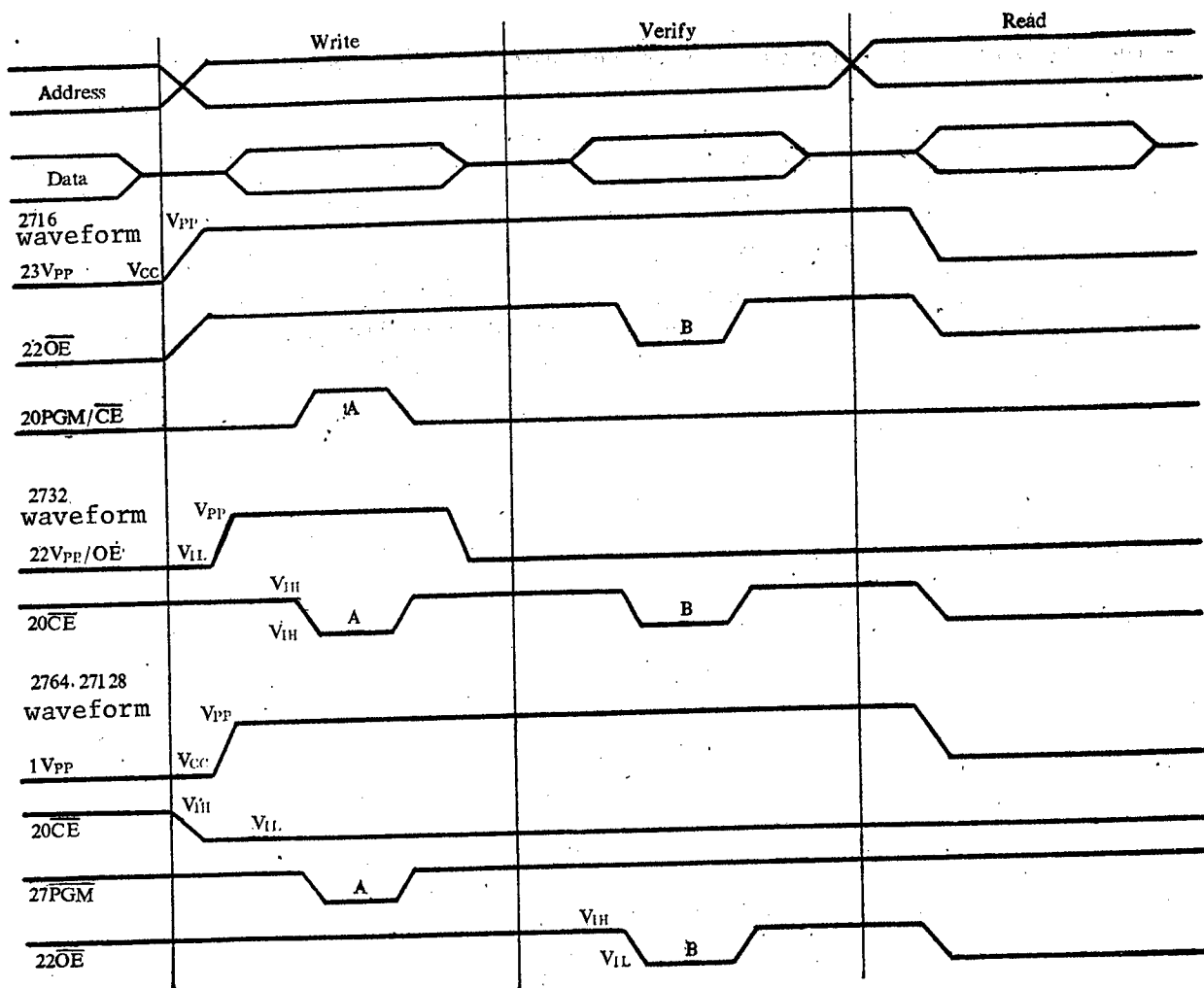
Figure 3.   Special Tri-State Circuit

Figure 4.   Programming Waveform Diagram

The special tri-state circuit is as illustrated in Figure 3. In the figure, V_{PPG} is the control signal of V_{PP}. When it is high, the V_{PP} voltage is open to V_{OUT}, and by the same principle, V_{CCG} is the control signal of V_{CC} (or logical "1") and when it is high, V_{CC} (or logical "1") is open to V_{OUT}; V_{LG} is low level (logical "0") control signal, and when it is high, it makes the V_{OUT} output low level. Combination logic design guarantees that at any time, only when one of the three control signals V_{PPG}, V_{CCG} and V_{LG} is high can the normal operation of the tri-state circuit be guaranteed.

The wave-form diagrams of the four types of chips are as illustrated in Figure 4. One can see from the diagrams the incompatibility of their pins, thus in the 8 D-type flip-flops, there are 3 flip-flops 16, 32, 64/128 for chip type select. Because the V_{PP}, PGM and OE control potential is sometimes high and sometimes low, the V_{CC} is powered up only during read/write. There are four other flip-flops that can be used for control. In addition, there are differences in the chip descriptions of PGM and OE, thus here we uniformly define the waveform which is at A in the waveform as PGM and the waveform at B, as OE.

The definition of the control flip-flops is:

V_{CC}	V_{PP}	PGM	OE		64	32	16

The control potential of the special tri-state circuit for controlling incompatible pins in the EPROM connector is decoded according to the demands of Figures 2 and 4 and the combine logical Boolean expression obtained is as follows:

Pin 1 : $V_{PPG1} = 64 \cdot V_{PP}$

$V_{CCG1} = \overline{V_{PPG1}} \cdot 64 \cdot \overline{V_{PP}}$

Pin 20: $V_{20} = [16 \cdot PGM + 32 \cdot \overline{PGM} \cdot \overline{OE}] \cdot V_{CC}$

Pin 22: $V_{PPG22} = 32 \cdot V_{PP}$

$V_{CCG22} = \overline{32} \cdot \overline{OE} \cdot \overline{V_{PPG22}} \cdot V_{CC}$

$V_{LG22} = \overline{V_{CCG22}}$

Pin 23: $V_{PPG23} = 16 \cdot V_{PP}$

$V_{CCG23} = 16 \cdot \overline{V_{PP}} \cdot \overline{V_{PPG23}} + 32 \cdot A_{11} \cdot \overline{V_{PPG23}} + 64 \cdot A_{11} \cdot \overline{V_{PPG23}}$

$V_{LG23} = \overline{V_{PPG23}} \cdot \overline{V_{CCG23}}$

Pin 26: $V_{CCG26} = 16 + 32 + 64 \cdot A_{13}$

$V_{LG26} = \overline{V_{CCG26}}$

Pin 27: $V_{27} = 64 \cdot PGM \cdot V_{CC}$

Pin 28: $V_{CCG}28 = 64$

According to the above Boolean expressions, the logic diagram is drawn as in Figure 1. The other parts of Figure 1 are of the 8255 program control chip and the address decoding of the 74LS273, but we will not go into detail about them here.

In short, combination logic decoding insures that during computer reset or software resetting 74LS273, pins which are incompatible with the power supply voltage are all in a grounded or free-floating state. When the software is only reading/writing the EPROM chip, it sends a definite content to the 8-bit control register. When read-write is finished, software immediately resets the control register to insure that the pins are grounded or in a floating free state to insure the safety of the chip.

III. The Intelligent Programming Algorithm

Using a general-purpose programming method (i.e., taking 50ms for each byte), the time necessary to program each byte is viewed as equal, and it requires only that it be executed according to a factory scale programming time to be able to achieve programming. In fact, the programming time demanded for each memory cell is unequal, the statistical curve of the programming time required by each cell is as illustrated in Figure 5: from this figure it can be seen that the overwhelming majority of EPROM cells can be programmed in 8ms and that only 2 percent of the cells requires 50ms to program. Clearly, programming the majority of the cells according to a standard in which the minority of cells takes longer to program is irrational. Thus, we propose the intelligent programming algorithm. The basic concept of the intelligent programming algorithm is to program each cell in actual programming time required (with the addition of a certain programming time factor to insure reliability).
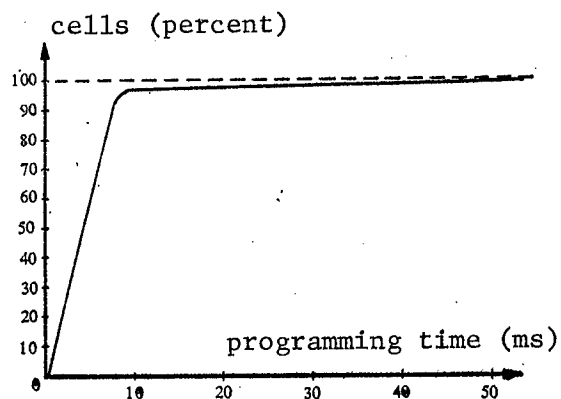

Figure 5. Programming Time Curve

The block diagram for the specific intelligent programming algorithm is illustrated in Figure 6.
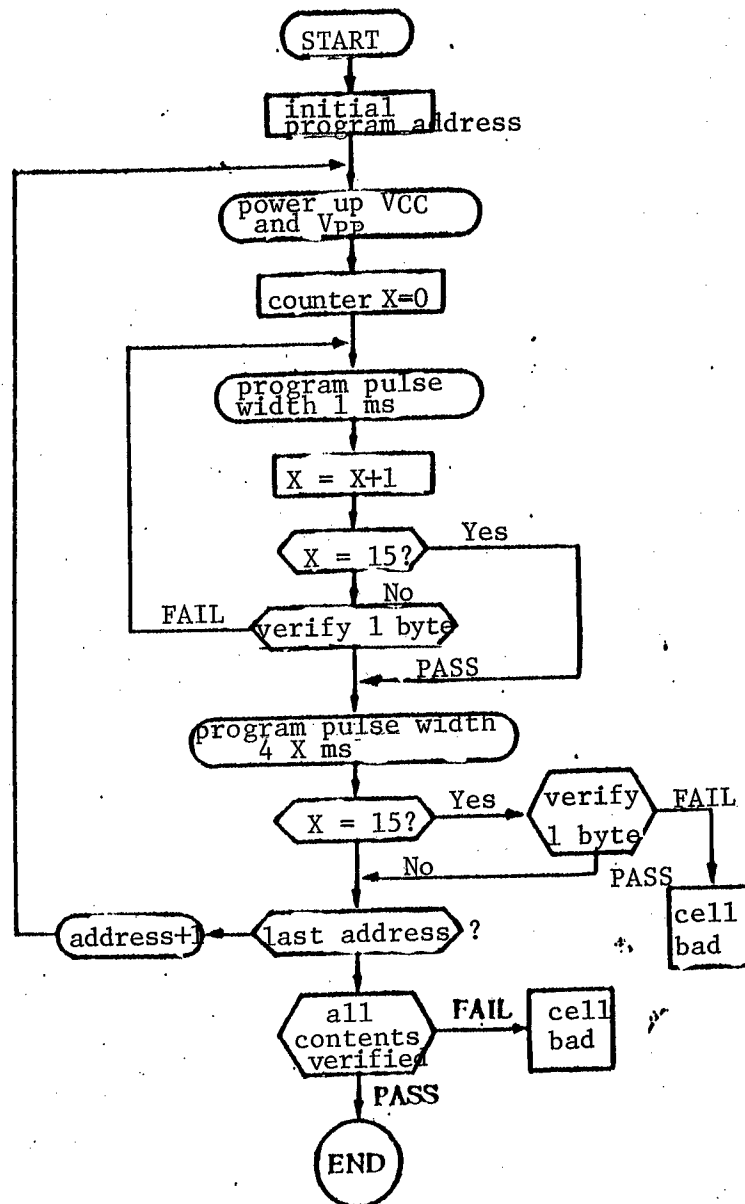
Figure 6. Intelligent Programming Algorithm Block Diagram

From the intelligent programming algorithm block diagram it can be seen that 1 ms after programming each cell, it is checked once, and the programming time for each cell X is clocked once, and this repeated programming and checking goes on until it checks out correctly or until X clock reaches 15 ms; finally, according to the value of X it is programmed again 4X-fold times in order to insure the reliability of the programming results. Thus, the overall programming time is 5X ms. In this way, the value of X is small for cells which are easy to program, and the total time required is also small, and the value of X is big for cells which are hard to program, and the total time required to program is also big. The programming time of each cell is distributed as

required but it is not all 50 ms saving on total programming time. From the algorithm block diagram it can also be seen that the greatest programming time is 75 ms. After certain cells have been programmed for 75 ms and a correct result has not been attained, the algorithm declares the cell defective (of course, when a component has not been erased clean, this phenomenon can also occur).

In short, the intelligent programming algorithm saves a great deal of time so that programming speed can be increased over 6-fold. This has special significance for programming large capacity EPROM chips.

IV. Disk Object File Programming Software

The applications software for the high-seed EPROM programmer runs on the TRS-80(I)/EG3200. This software is disk object file oriented, that is, in addition to having such functions as read, search, check and writing the contents of RAM to the EPROM chip, this programmer and the software also can directly write a disk target file directly to the EPROM chip, thus resolving the problem of the program being free floating because the address is not used to replace the true. In addition, the entire operation is carried out under the direction of complete and clear interactive dialogue of the software, requiring only that the operator carry out operations according to the prompt information to be able to achieve correct results. For detailed explanations and program block diagram related to this software, please refer to the article SINGLE-CHIP MICROPROCESSOR PROGRAMMER in this issue. If the dashed line part of the program block diagram is dropped, and replaced by the WRITE program part using the intelligent algorithm, the whole thing would be applicable here.

V. Conclusion

The design of this programmer and the software have already been finalized and spread and in September 1984 they passed appraisal. After technical testing by the experts at the meeting, they all felt that it had achieved advanced levels for similar products abroad, and that it had special significance for programming the high capacity 2764/27128 EPROM chips.

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APPLIED SCIENCES

PROGRAMMER FOR SINGLE-CHIP MICROPROCESSOR

[Article by Li Benren [2621 2609 1804], Gong Ganghua [7895 0474 5478] and Meng
Qi [1322 1142], Shenyang Computer Institute, Chinese Academy of Sciences:
"Programmer for Single-chip Microprocessor"]

[Text] Abstract: This paper introduces the 8748/8741/8755
single-chip microprocessor programming part of the TRS-80(I)/
EG3200 on-line software development system. This program can
read the internal ROM and program the internal EPROM of the
8748/8749, 8741/8742 and 8755 chips. It is a development tool
for single-chip microprocessors which is very convenient,
reliable and has powerful functions.

I. Introduction

A single-chip microprocessor integrates on a single chip the CPU, RAM, ROM
and I/O "components" and includes almost all the functions required by a
digital processing system. Because of its powerful and flexible processing
ability and excellent performance/price ratio and single power supply, it is
becoming increasingly used in small-scale control devices, intelligent instru-
ments, and computer peripherals and even as necessary spare parts for devices
that demand small size. Therefore, developing applications for single-chip
microprocessors is becoming more and more highly regarded and in scientific
research and production the problem of reading out the internal ROM and pro-
gramming the internal EPROM of single-chip microprocessors urgently requires
solution. Yet, the prices of the large-scale development systems for devel-
oping the functions of single-chip microprocessors are very high and they are
not things which all units developing single-chip microprocessor applications
have the wherewithall to import. Thus, to meet the urgent needs of the
majority of domestic scientific research and production units, we have devel-
oped and finalized design on an 8748/8741/8755 single-chip microprocessor
programmer which is easy to operate and has powerful functions for the TRS-80
(I)/EG3200 microcomputers and the Z80 single-board computer which have the
most users in China.

This programmer has MCS-48 cross assembly editing language, UPI cross assembly editing language and programming software. While programming the 8748/8741/ 8755 chips, it can also solve programming of the 8748/8749, 8741/8742 micro-processor programs. This programmer can be used with the TRS-80(I)/EG3200 microcomputers (including those with Z80 CPU bus, and other microcomputers that can run TRS-80(I) NEW DOS operating system) and can also be used with the Z80 single-board computer. Programmer design includes software and hard-ware reset, program controlled power up and down, the checking whether the single-chip microprocessor insertion is correct (except for the 8755) func-tions, thus insuring the safety of the single-chip microprocessor. In addi-tion, while used on the TRS-80(I)/EG3200 microcomputers, the programming software is disk object file oriented, and it can write a disk object file directly to the internal EPROM of the single-chip microprocessor. When used with the Z80 single-board computer, the programmer operates under the control of the program software (on a 2716 EPROM chip) we provide, with parameters set by the single-board computer control program.

II. Design of Programming Circuit

The design of the programmer hardware circuit must satisfy the demands of the design task: i.e., to implement the read, write, check and verify functions of compatible 8784/8749, 8741/8742 and 8755 chips in a single socket and at the same time, to insure the absolute safety of the chip, it is necessary to have a software/hardware reset and the capability of controlling power up/down and checking whether or not the chip is seated correctly to insure that the pins received only the signal voltage demanded at the moment of read/write operations and at other times, all pins are floating empty or at low level, thus insuring the safety of chip insertion and removal and if an error in chip insertion is discovered, it can be promptly corrected.

To program a variety of kinds of chips in a single socket it is necessary to inspect the programming of each chip type and check the waveform, check the compatibility of the pins of each chip for the control signals demanded, and correctly process the control signals of incompatible pins. On inspection we discovered that the programming and checking waveforms of the 8748/8749 and 8741/8742 chips are uniform, illustrated in Figure 1, with the difference being EA, PROG (relative V_{DD} is low for about 4 diodes pressure drop) and there are differences in V_{DD} voltage for different chips. As illustrated in the table below, the V_{DD} demands for different chips are different.

Model	8748	8749	8741	8742	8755	8048	(read only)
$V_{DD}(V)$	21	20	25	21	25	12	

Because the V_{DD} power supply is connected externally, when programming, the user can make adjustments as required. And EA and PROG are supplied after V_{DD} goes through four diodes. (See Figure 4) The programming waveform of the 8755 chip is entirely different from the two above-described chip types, as shown in Figure 3.
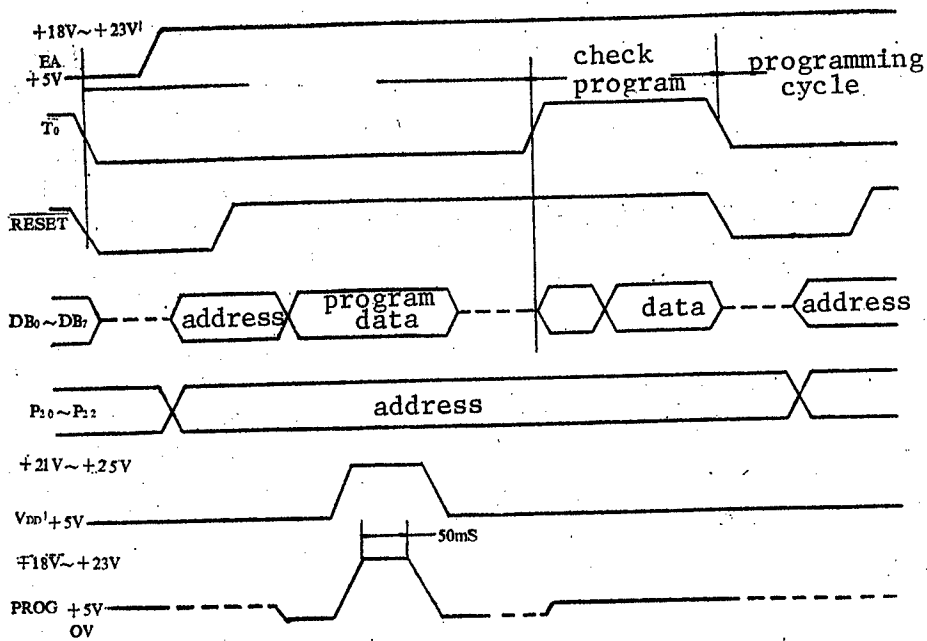
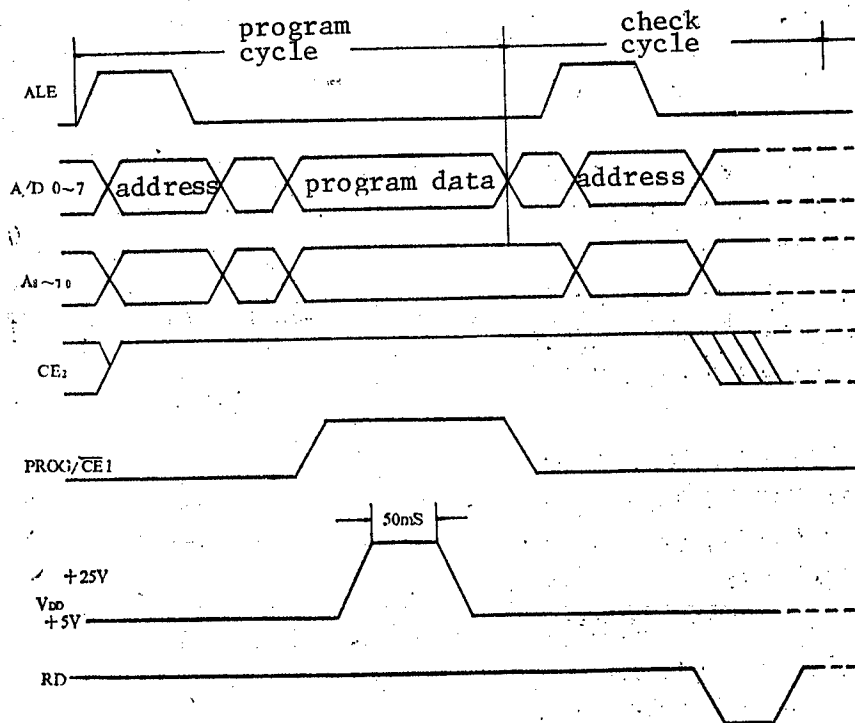Figure 1. Diagram of 8748/8749, 8741/8742 Combined Programming Waveforms

Figure 2: 8755 Programming Waveform Diagram

Now, we will inspect the compatibility of pin signals of these three types of chips. For this, the diagram of the pins of the three types of chips are illustrated in Figure 3. In the figure, the pins of all other chips which are completely the same in name and function as the pins of the 8748 chip are not shown. The names of the 8755's $AD_{10}-AD_0$ are different from the 8748's (Figure 3), and when actually programming, the signal is completely compatible (see Figures 1 and 2), thus they are also compatible in the circuit (Figure 4).

Figure 3. Chip Pin Diagram

Figure 4. Programmer Circuit Principles Diagram

32
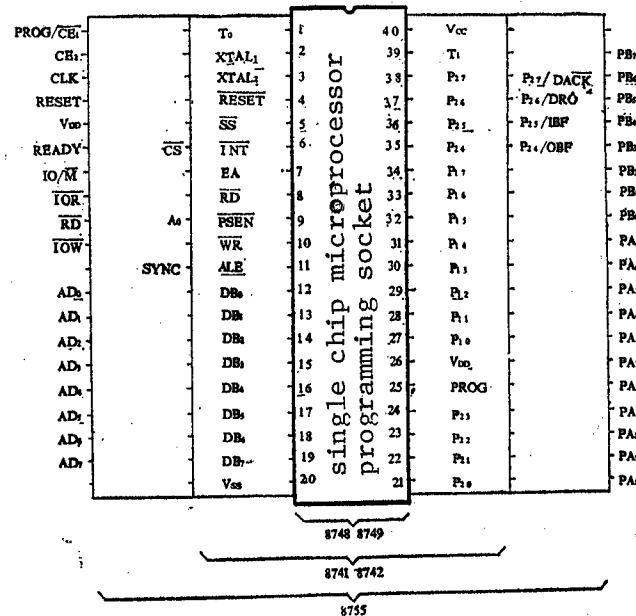
Based on the demands of waveform diagram, pin function compatibility, software/hardware reset, program controlled power up/down, and checking the correctness of chip insertion, the diagram of the principles of overall design of the single-chip microprocessor programmer circuit are illustrated in Figure 4.

The 8748/8741/8755 single-chip microprocessor programmer is a part of the TRS-80(I)/EG3200 on-line software development system. From Figure 4 it can be seen that the hardware is actually a microprocessor external interface device. To make the hardware structure simple, we used few components. We selected the Intel Company's 8255 general purpose programmable parallel interface circuit as the main support logic, and used some other components and a programmable socket. The 8255 uses operations mode 2, and an ideal bidirectional bus is supplied by the PA kou [0656]. It is both a data bus and the address bus for the bottom 8 bits. The PA kou control signal $\overline{ACK}$, $\overline{STB}$ is supplied by PC_1 and PC_2 so as to control the PA kou to sent data (or addresses) or receive data. The PB_0-PB_2 of PB kou is the HI address line. The other PB kou leads together with PC_0-PC_2 of PC kou with the addition of 8 74LS273 D flip-flops and 2 74LS74 dual D flip-flops carry out control of the programming levels of the 8748/8741/8755 chips. Under the control of editing software, by means of the control signal which is provided through the decoder circuit and which corresponds to the programming waveform diagrams of the above described chips, when programming is completed and after the host computer reset and the software reset, the socket pins which are not compatible with the power supply are all grounded or in the floating free state so that when the chip is removed, its safety is insured.

For control signals for the incompatible pins, the control signal is realized in the close combination of hardware and software. For example, when programming the 8748, for pin 9 of the single-chip microprocessor (see Figures 1, 2, 3 and 4), programming software makes the 8255 chip's PB_5 and PC_0 high potential, so that pin 9 is in the floating free state; when programming the 8741, the software makes PB_5 high level and the PC_0 low level, so that pin 9 is a low level control signal; when programming the 8755, software makes PB_5 low level and PC_0 high level thus controlling the D_7 position of the flip-flop by means of the 8755 read signal ($\overline{RD}$) identification, directly applied to pin 9 and carrying out the changes under program control as in the demands of Figure 2.

Pins 7 and 25 of the single-chip microprocessor socket require a special level tri-state switch circuit to realize the demands of the programming waveforms. This special tri-state switch circuit is discussed in detail in the article HIGH-SPEED GENERAL-PURPOSE EPROM PROGRAMMER which appears in this issue; interested readers should consult this article as the description will not be repeated here.

From Figure 4 it can be seen that the circuit is equipped with a hardware reset. The software reset is a complete "0" message written to the control flip-flop. To test whether or not the 8748/8749 and 8741/8742 chips are socketed correctly, under software management, pin 11 of the single-chip microprocessor is constantly tested to determine whether or not there is a signal pulse output, and if there is no signal pulse output, it indicates that the chip is socketed incorrectly, and software will prompt resocketing

the chip (see Figure 5). From Figure 4 it can be seen that V_{DD} and other high pressure all are under program control, through the switch circuit added to the program socket, when the program is finished, software immediately resets, cuts off high pressure and insures the chip's safety.

From this it can be seen that the hardware design of this programmer takes the absolute safety of the chip into full consideration. At the same time, software and hardware also are closely combined together.

III. Programmer Functions and Program Block Diagram

The programming software which this programmer supplies has very powerful programming functions, in particular, this software is disk object file oriented and can write a disk object file directly to the program chip. The programmer has four functions: read, write, check and verify:

READ   -- reads the contents of the internal EPROM (or ROM) of the single-
              chip microprocessor to any RAM area.

CHECK   -- checks whether or not the single-chip microprocessor's internal ROM
              has been completely erased, and if not, software will list the
              EPROM addresses of the unclean cells on the screen.

VERIFY   -- verifies that the content of the program is correct. It compares
              the contents of the EPROM region being verified with the desig-
              nated region of memory (where the information was originally) and
              if it encounters different cells, it lists on the screen the EPROM
              addresses of the incorrect (or different) cells.

WRITE   -- 1: writes the data from a region in memory to the EPROM in a
              single-chip microprocessor and verifies the results of writing.
              2: writes an object file from disk directly to the EPROM in a
              single chip microprocessor and verifies the results of writing.

The above functions are all carried out through interactive dialogue, as illustrated in Figures 5 and 6. The program flow and the operational method are all clearly and completely indicated by the interactive dialogue prompts in the figures and no addition explanation is necessary to obtain correct results under the guidance of the interactive dialogue. When what you have keyed in is incorrect information, the computer will tell you, and let you key it in again (this is not indicated in the program flow chart). The execution process of the functions given in Figures 5 and 6, also portrays the dialogue information in the block diagrams at the same time in order to clarify the operational method and process. The English in the block diagram is the dialogue and prompt information provided by the software, the horizontal lines after the English indicate the information which the software demands the operator key in at this point.

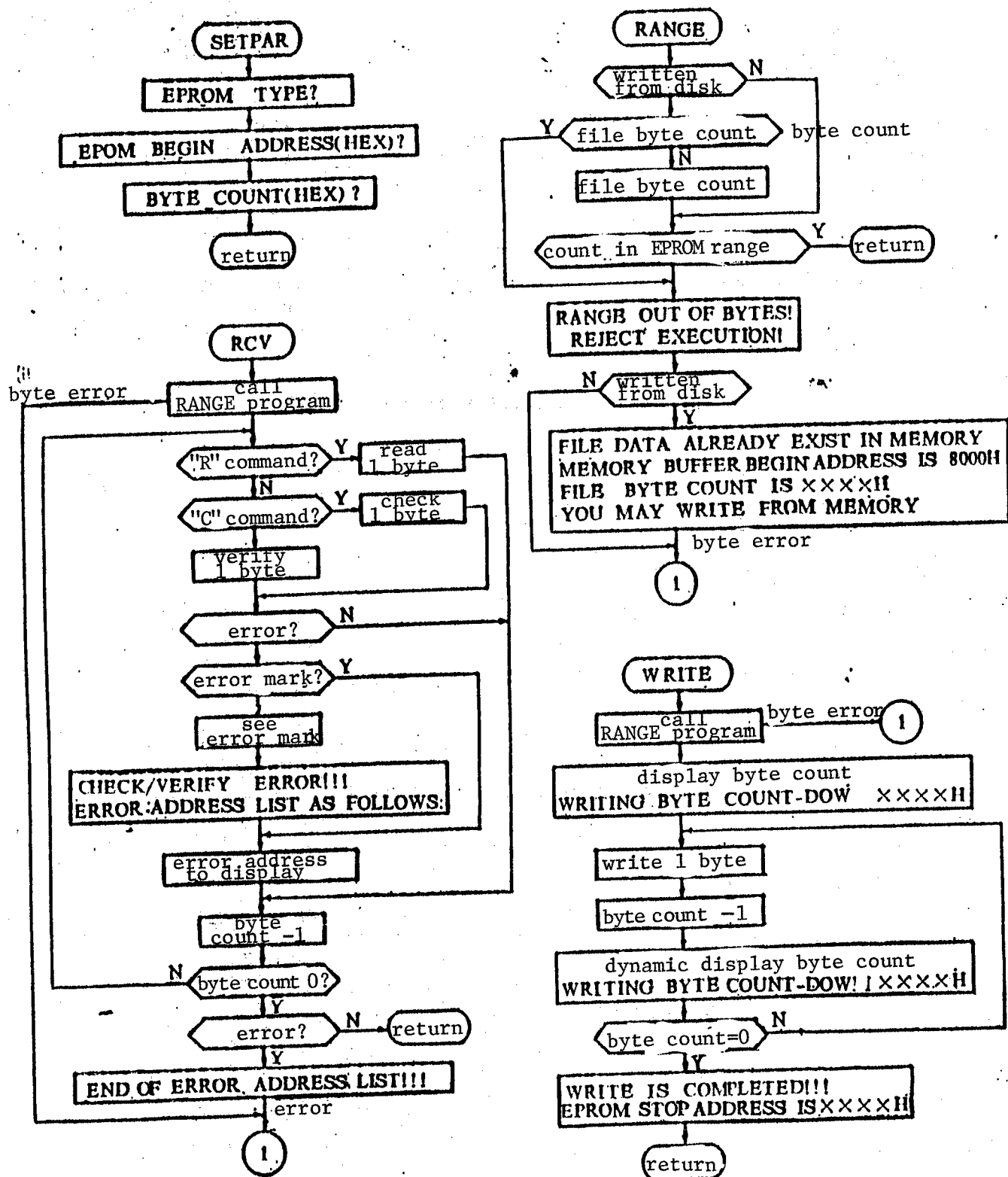When asked WHICH COMMAND?--, reply "B," then you will return to NEW DOS.

SETPAR

EPROM TYPE?

EPOM BEGIN ADDRESS(HEX)?

BYTE COUNT(HEX)?

return

RANGE

written from disk — N

Y — file byte count > byte count

N

file byte count

count in EPROM range — Y — return

RANGE OUT OF BYTES! REJECT EXECUTION!

N — written from disk

Y

FILE DATA ALREADY EXIST IN MEMORY
MEMORY BUFFER BEGIN ADDRESS IS 8000H
FILE BYTE COUNT IS ×××H
YOU MAY WRITE FROM MEMORY

byte error

①

RCV

call RANGE program

byte error

"R" command? — Y — read 1 byte

N

"C" command? — Y — check 1 byte

verify 1 byte

error? — N

error mark? — Y

see error mark

CHECK/VERIFY ERROR!!!
ERROR:ADDRESS LIST AS FOLLOWS:

error address to display

byte count −1

byte count 0? — N

Y

error? — N — return

Y

END OF ERROR ADDRESS LIST!!!

error

①

WRITE

call RANGE program — byte error — ①

display byte count
WRITING BYTE COUNT-DOW ××××H

write 1 byte

byte count −1

dynamic display byte count
WRITING BYTE COUNT-DOW! ××××H

byte count=0 — N

Y

WRITE IS COMPLETED!!!
EPROM STOP ADDRESS IS××××H

return

Figure 5. Programming Software Block Diagram

mam prog.

TRS-80 DISK OBJECT FILSE EPROM UTILITY COMMANDS·
  READ----PREE "R"   CHECK---PRESS "C"
  VERIFY PRESS "V"   WRITE---PRESS "W"
  BACK----PRESS "B"

I.

prog.initial

CHIP INSERTION MODE ERROR!!!
PLEASE CORRCT INSERTION OF CHIP!!!

YOU MAY INSERT/REMOVE CHIP NOW.

IS IT 8755 (REPLY "Y" OR "N" AFTER INSERTION CHIP)?   N   insert OK?
Y

ret. to sys   B   WHICH COMMAND?   R.C.V

CHECK CHIP (READY "Y" OR "NO")?   call SETPAR prog

N   checked?   "C" command?   Y
Y   N

"C" command   MEMORY BEGIN ADDRESS(HEX)?

call SETPAR prog   call RCV prog.   error

call RCV prog.   "R" command   Y   END OF READ!!!!
N

"C" command   Y   CHECK IS COMPLETED!!!
                        ALL RIGHT!!!
N

DATA FROM MEMORY/DISK(REPLY "M"/"D")?   VERIFY IS COMPLETED!!!
                                          ALL RIGHT!!!

"M" or "D"   M

DISK OBJECT FILE SPECIFICATION?

open file   MEMORY BEGIN ADDRESS (HEX)?

call decode device program +
compute file byte count

pass check   Y

call SETPAR prog

call WRITE prog

set "V" command

call RCV prog.   error

WRITE & VERIFY ARE ALL RIGHT!!!!

Figure 6.   Subprogram Function Block Diagram

36

The programmer has a function (except for the 8755) which checks whether or not the single-chip microprocessor is inserted correctly. If the chip being programmed is not an 8755 (but is 8748/8749 or 8741/8742), and at IS IT 8755 (REPLY "Y" OR "N" AFTER INSERTION CHIP)?--you key in "N," the software will automatically check whether or not the chip is inserted correctly.

EPROM TYPE?--requires that you key in the model of the chip to be programmed (because dialogue principles similar to the high-speed general-purpose EPROM programmer were adopted, to make it easy to remember, here we did not use a single-chip microprocessor model dialogue indicator). When reading the ROM of a single-chip microprocessor, such as the 8048, the 8748 model compatible with the 8048 should be keyed in so that the read operation can be completed. EPROM BEGIN ADDRESS?--, BYTE COUNT?--, and MEMORY BEGIN ADDRESS?-- require that hexadecimal numbers be keyed in. Only the last four places of numerical values keyed in are accepted, and when there are not four places, zeros are automatically added to the front positions. The xxxx after the English indicates hexadecimal prompting information given by the program, of which EPROM STOP ADDRESS IS xxxxH, both indicates the stop address as well as the beginning address of the when writing next. At any time other than the programming process, by simultaneously pressing the keys, J, K and L, all the English dialogue displayed on the screen can be recorded on a printer.

When writing a disk object file, the object file extension must be /CMD or /CIM otherwise it will refuse acceptance; if the file bytes are too many (exceed the range determined by EPROM parameters), the program will refuse file writing and at the same time will present prompt information indicating the initial address of the file data loaded into the RAM buffer and the file length, and suggest that the data segments be taken from the RAM buffer and written to the internal EPROM of the single-chip microprocessor or expanded to the EPROM chip. The Chinese notes in the block diagram explain the internal flow of the software.

In the program block diagram, in addition to the main program, there are also several subprograms. They are: SETPAR, the set parameters program (SETPARA-METERS), RANGE, the program that checks the range of the EPROM's word length, RCV (READ, CHECK, VERIFY) program that executes reading, checking and verification, and the WRITE program which does the writing.

The program block diagram describes comprehensively the programming software's flow and functions. It is worth noting that if one carries out check checking under the write function, the number of bytes of the chip being checked is the number of bytes written, and the two must be the same; if the data written comes from disk, the number of bytes must be greater than the number of bytes of the disk object file, otherwise it will refuse to write, and will suggest a write method in the interactive dialogue. When the number of bytes is greater than the number of bytes of the object file, writing will be according to the number of bytes of the actual object file.

IV. Z80 Single-board Computer Controlled Single-chip Microprocessor Programmer

When linked with a Z80 single-board computer, in terms of hardware, it is only necessary to link the control signal required by the single-chip microprocessor programmer with the corresponding signal of the Z80 single-board computer.

When linked with a Z80 single-board computer, the programmer still has the four read, write, check and verify functions. Its programming software is on an EPROM chip. The software requires that before programming, the user uses the monitor program of the single-board computer itself to load the program and the operating parameters established. The specific functions and the definitions of related parameters are explained below.

When linked to a single-board computer, the programmer has the following four functions:

READ   -- reads the contents of the single-board computer's internal EPROM or ROM to the RAM area with 2000H as the first address.

CHECK   -- checks whether or not the chip's internal EPROM is erased. If cells which have not been erased clean are encountered, it displays the EPROM address of that cell and the check error indicator.

VERIFY -- verifies whether the content of the programming is correct. It compares the contents of the designated area in the chip with the contents of RAM at initial address 2000H. If a cell that doesn't conform is encountered, it displays the EPROM address of that cell and the check error indicator.

WRITE   -- writes the data at initial address 2000H in RAM to the EPROM in the single-chip computer and checks the results. If there is an error, it displays the corresponding error indicator.

The format of the display information is as follows:
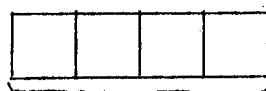
```
┌──┬──┬──┬──┐        ┌──┬──┐
│  │  │  │  │        │  │  │
└──┴──┴──┴──┘        └──┴──┘
 EPROM address        indicator
```

The indicator information and its meaning is listed below:

Indicator		Meaning
0	10000	chip insertion error (except for 8755)
1	H	chip reading finished
2	H	chip checking finished and correct
2	10000	chip checking error
3	H	chip verifying finished and correct
3	10000	chip verifying error
4	H	writing and verifying finished and correct
4	10000	post-writing verifying error
5	10000	chip capacity exceeded error

The Z80 single-board computer programmer software is all fixed in a 2716 EPROM chip. The address space occupied by the chip in the single-board computer is the EPROM socket with 0800H as the initial address. The software requires that the RAM parameters setting cells at 2F90H-2F95H thus the user address space is from 2000H to 2F8FH (when data being written is larger than this space, the data can be written in segments two or more times, thus each write can be any number of bytes). These parameter setting cell definitions are as follows:

Address	Meaning
2F90H	chip model number
2F91H	operation function
2492H	low byte of chip begin address
2F93H	high byte of chip begin address
2494H	low byte of number of operation bytes
2F95H	high byte of number of operation bytes

The parameter definitions of the chip model number cells and operation function cells are:

Model No	2490H value	Function	2F91H value
8748	1	READ	1
8749	2	CHECK	2
8741	3	VERIFY	3
8742	4	WRITE	4
8755	5		

The chip starting address and the number of bytes are set by the user in hexadecimal format.

Now we will explain the specific operation process:

After the hardware linkage of the programmer and the single-board computer, the 2716 EPROM software we provide is plugged into the EPROM socket at address 0800H, a +5V power supply is added, then V_{DD} is added, and the single-board computer is reset. Then the operation process of the single-board computer programmer is entered.

I. Setting parameters: After your data has been loaded using the single-board computer's monitor program (when verifying and writing), on the basis of the above-described set parameter cell definitions, the parameters are set in accordance with your operational demands. After the parameters have been set, the chip is inserted, and the programming software is started in monitor state (initial address is 0800H), and the programmer carries out the functions defined.

First the programming software checks to see if the program chip has been inserted correctly (except for the 8755). If it is incorrect, a "0 10000" will be displayed at the indicator position and you will have to reinsert the chip after reset. If it is correct, then it checks to see if the number of bytes is within the range of the chip's capacity. If there is a capacity range error, then the corresponding indicator is displayed; if it is within the capacity range, then it carries out the operations you defined. In the process of operation, if an error occurs, the corresponding error indicator described above is displayed. If it is correct, the corresponding indicator described above is also displayed. When the error indicator is displayed, the EPROM address display portion will display correspondingly the address of the cell in error.

In the programmer's write process, it dynamically displays the programmed EPROM address.

II. When each function operation is concluded (a correct conclusion or an incorrect conclusion), the program automatically resets the programmer (which can also be reset to monitor state by using the single-board computer's reset button). After reset, the chip can be removed. Then in monitor state, your operations can be redefined and started.

V. Conclusion

Summarizing the above, the 8748/8741/8755 single-chip microprocessor programmer software and hardware and the MCS-48, UPI-41 cross-editing assembly language, have resolved the problem of programming the 8748/8749 and 8741/8742 single-chip microprocessors and the 8755 EPROM's and a method of programmed programming, and have resolved an urgent need in domestic scientific research and production. It passed appraisal in September 1984 and went into small batch production.

Through the development of this programmer, we feel that based on China's national circumstances the development tool which has powerful functions, is inexpensive and makes things flexible and convenient for the user has very practical significance. Therefore, we are further intensifying development of single-chip microprocessor emulators matched with it to provide better debugging techniques for developing applications single-chip microprocessors.

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APPLIED SCIENCES

DIGITAL VOLTMETER TECHNOLOGY ACQUISITION

Beijing GUOJI MAOYI [INTERTRADE] in Chinese No 3, 1985 pp 33-34

[Article by Chen Qilin [7115 0796 2651] and Cui Jianping [1508 1696 1627]]

[Text] China began its development of digital voltmeter at a fairly early stage. In 1965, the Beijing Radio Technology Research Bureau had already built a 5-digit voltmeter whose technical performance was comparable to the international standards at that time. However, at the present time, of the more than 50 models of 5-digit voltmeters produced by State-designated factories, only 2 or 3 use the IEC-IB international standard interface and microcomputer technology; further-more, due to the limited capability in processing, equipment and testing, they cannot be mass-produced. As a result, the gap between the Chinese standard and international standard in digital voltmeter is further widened.

In order to change the stagnant condition in the development and production of digital voltmeters in China, an effort was initiated in 1980 jointly by the Ministry of Electronic Industry Component Administration Bureau, the National Materiale Bureau No 1 Electro-Mechanical Department, the China Electronic Technology Import-Export Company, and other organizations in Beijing to import foreign technology. Specifically, after careful analysis and repeated comparisons and inspection tours, the Beijing Radio Technology Institute prepared a plan to import the manufacturing technology of the 8520A digital system multimeters from the U.S. FLUKE Co by using foreign exchange funds designated for mechanical and electrical instruments under the joint technology and trade program. In September 1981, an official contract and an agreement for technology cooperation were signed.

The items imported in the 8520A technology and trade program can be divided into 3 stages:

1. Import automated test and standard systems which are built using advanced technologies of the 1980's. Train personnel and begin SKD production.

2. Import key production equipment to coordinate with China's existing facilities. Modify the production lines based on FLUKE's advanced technology and begin CKD production.

3. Use the results of imported technologies in other research projects to stimulate development in related technologies.

The U.S. FLUKE Co is devoted to the research and production of electronic instruments. With 2,700 employees, it has an annual sale of 170 million dollars, and has more than 170 product types. In the mid 1970's, the FLUKE Co. invented the principle of remainder-recycle A/D conversion, and developed a series of unique high-speed (500 times/sec) and high-precision (5 PPM) digital system multimeters. During the 1983-1984 period, FLUKE's products accounted for 55 percent of the 180 million-dollar digital voltmeter market world wide. The 8520A is a product first marketed in the early 1980's. Its analog and digital sections are controlled by the 280A and 8048 microcomputers respectively, and its software is written in structural programming language. Its production process is under strict quality control, and its overall performance is considered to be the best of all the multimeters available today.

Being a late comer in dealing with this country and very anxious to get into the Chinese market, the FLUKE Co was willing to enter into a technology cooperation agreement, and transfer to us its manufacturing procedures and advanced technologies. This is the reason we chose FLUKE to be our technology trade partner and decided on the 8520A as our prototype product. Through the technology cooperation agreement, FLUKE's sale in China had multiplied; in 1984, it exceeded 5 million dollars, half of which was attributed to technology-trade products. On the other hand, as a result of the technology and trade cooperation effort, Chinese personnel have gained a much better understanding of the technical characteristics of FLUKE's products, and greatly enhanced FLUKE's reputation in China through advertisement of the cooperative products. Such introductions are much more effective than commercial advertisement or technical description of product performance.

In the interest of mutual benefits, the Beijing Radio Technology Institute and the FLUKE Co entered into a 4-year technology and trade cooperation agreement. During this period, the technologies of four different types of digital voltmeters have been imported, which resulted in significant technical, economic and social benefits.

1. Technical Benefits

During the period of the cooperative effort, 17 engineers from this Institute have received training at the FLUKE facility located in Everett, Washington; the FLUKE Co has assigned 7 engineers in 4 different groups to provide technical assistance at our Institute. Through training and personnel exchange, we have acquired nearly 200 documents on key technologies, advanced processes, and management procedures. This allows us to accomplish the following:

(1) quickly become proficient in the principle of remainder-recycle A/D conversion, the design of dual microcomputer systems, structural programming languages, and computer-controlled automatic tuning and testing procedures, thus raise our design standards into the age of the 1980's.

(2) solve the lingering problem of China's electronic industry. Through imported technology, we not only have mastered a complete set of FLUKE's advanced procedures and installed first-class equipment, but also have made significant progress in conceptual and theoretical understanding. For example, we have implemented quality-control measures such as static electricity prevention, cleaning of print boards, cyclic shock tests at high and low temperatures in order to effectively eliminate early component failures and improve the reliability of the overall product. These are problems which previously have not been studied in depth either in theory or in practice.

2. Economic Benefits

Under the 8520A technology and trade import agreement, and with the assistance from FLUKE, we had established plans for technological renovation. We spent only 460,000 dollars to import 133 units of sophisticated production equipment; at the same time, by making use of existing facilities, we spent only 125,000 yuan in factory remodeling, and built the first state-of-the-art digital voltmeter production line in China's electronic industry.

This production line was completed and began operation in August 1983. By 30 September 1984, it has produced 470 8520A units which met FLUKE"s quality standards. Its customers are distributed over 19 provinces and cities, and it has been cited by the State for making important contributions to many engineering projects. Since production began a year ago, the acceptance rate of the 8520A unit has been maintained at 85 percent, and the number of units returned for repair has been less than 4 percent; new units and equipment have been 100 percent free of defects. Today the investments on imported equipment and renovation of domestic facilities have been totally recovered, and annual profits have reached 1 million yuan.

Furthermore, since the performance of Chinese-made digital meters failed to satisfy user requirements, each year the State had to spend large amounts of foreign exchange funds to import entire units. Now we are importing manufacturing technologies and CKS's of advanced products under the technology and trade cooperation agreement; based on the number of imported CKD's alone, the State can save nearly 1 million dollars. Also, the users are now protected by reliable maintenance and repair services and technical support, they no longer have to suffer the problems associated with the imported "Wan Guo" products.

3. Social Benefits

Importing the manufacturing technology of 8520A not only changed the backward status of technologies and procedures of this Institute but also promote the development of a series of related items such as welding aids, resistance welding flux, cleaning agent for wave peak welding machines, and foam materials used for packaging. By using the information and data provided by FLUKE, we have conducted tests of many chemical processes, 5 of which were successful, and two have been transferred to factories for use in actual production.

In an effort to familiarize the users with the operation of 8520A, we have conducted technical seminars around the country, invited users to visit our production line, and designed operating procedures for the users. These efforts have promoted technical advances in the areas of automated measurement and automatic control techniques for a variety of industries.

During the several years of cooperative efforts with FLUKE, we have learned the following:

The electronic instrument industry is a highly technology-oriented industry. It has a great variety of products which are relatively small in size but undergo rapid changes. To develop new products requires a large amount of investment and appropriate talents and policies; it also requires good foundation in chemical and metallurgical engineering. Therefore, by identifying a partner who is technologically advanced and willing to cooperate, by focusing on a prototype product which has the potential of bringing along other products, and by establishing the partner's confidence with large quantities of unit orders, we can enter into an agreement of technology and trade cooperation for the purpose of importing advanced technologies, advanced processes, and advanced equipment. This is a shortcut to building up China's electronic instrument industry; the success of importing 8520A is a very good example.

We also learned from the experiences and lessons over the past few years that technology and trade cooperation should not stop at the level of imported products, because what was originally advanced technology may become obsolete very quickly. On the basis of the imported 8520A technology, we have developed the baseline 8050A and the mid-line 8840A products; we are also planning to import the top-line 8506A. But these efforts only brought us close to the current world standards. To take the next step, we must rely on our own conviction and on the talents and intelligence of our own technical personnel; by seeking international technology cooperation on an even higher level, we can raise the standards of China's electronic instrument industry to the ranks of the developed countries.

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APPLIED SCIENCES

SUGGESTIONS FOR FURTHER APPLICATIONS OF HFETR IN CHINA

[Article by Zhang Zhaoyuan [1728 5128 3293]]

[Excerpt] The main purpose of building HFETR in China is to develop power reactor fuel and material, and also to promote isotope production. Since the start of operation it has made significant contributions toward the above objectives. However, the current status of material and fuel research is less than satisfactory, and the high costs of fuel and operation adversely affect the production of urgently-needed isotopes. For this reason, we propose the following suggestions:

1. Concentrate on the Development of Irradiation Equipment and Circuits and Increase Efforts in Fuel and Material Testing.

The 500 kW high-temperature (350°C) and high-pressure (150 atmospheres) water circuit of the HFETR will be completed in the near future; it will provide an effective means for testing Chinese-built, small power plant components. This work is highly significant in the sense that it represents an independent effort by this country to surpass the advanced standards of other countries. China already has a large team of trained personnel in the design, manufacturing, testing, and inspection of fuel elements. Past accomplishments and technical expertise have demonstrated China's capability in producing components for nuclear power plants. As mentioned earlier, current efforts in other countries are concentrated on both circuits and equipment; because of the high cost of testing and the long testing time, there is a limit to the number of circuits that can be added, hence irradiation equipment appear to play a more important role. It is suggested that in HFETR, efforts be devoted to test irradiation equipment with respect to fuel power circulation, abrupt power surge, and transient power excess conditions. Work in this area is receiving a great deal of attention in other countries because it is closely related to the efficient operation of power plants. As the proportion of nuclear power plants increases, the power will increasingly fluctuate with load conditions. For example, it may operate at full load during the day, but only 40 percent of full load at night; in many instances it is during the change-over period that single-rod failures occur. Therefore, this research is highly significant in terms of establishing safety limits, developing the potential of fuel elements, and improving technical design.

Satisfactory results have been obtained in applying HFETR irradiation testing procedure to prototypes of pressurized containers used in China's power plants. Future efforts should be concentrated on extending the depth and breadth of this research; this implies developing irradiation tests based on fracture mechanics, which requires developing irradiation techniques inside the reactor and inspection procedures outside the reactor. In addition, activities abroad in developing new products of steel should be closely monitored so that a limited research and test effort can be carried out based on China's available resources.

2. Increase the Utilization Rate of Reactors by Alternating High-Power and Low-Power Operations.

Today, China's HFETR only operates 50-75 days under high-power conditions; the average consumption rate of fuel elements is around 40 percent. According to the results of nondestructive inspection of irradiated elements, they can be further exploited to raise the consumption rate to 45 percent under low-power conditions (e.g., at 3500 kW). Preliminary estimates indicate that these elements can continue to operate for an additional 3 months under low-power conditions; therefore, it is quite feasible to consider alternating high-power and low-power operations for HFETR.

Currently, many jobs can be done under low power. For example, in the production of isotope $^{99}M_o$- $^{99}T_c$ "cow" for medical use, the half life period of $^{99}M_o$ is only 67 hours; therefore, the reactor must be operating continuously to provide a continuous supply of $^{99}M_o$. In both the United States and Japan, $^{99}M_o$ is the number one isotope used in medicine. At present, we have successfully produced the $^{99}M_o$- $^{99m}T_c$ cow with a height ratio of 2 curie/g on the HFETR; this fills a void in China's current needs and builds the foundation for a promising future. Alternating high-power and low-power operations can also reduce the decay of height ratio C^{60}_o after the reactor is shut down. After several years of small-scale production of single-crystal with neutron mixing, it has established a good reputation with users; larger scale production can also be accomplished under low power. Of course, to implement alternating high and lower power operation in the same reactor will lead to difficulties because of the complicated targets or irradiation equipment and inverted positions. But these problems can be solved by a balanced approach; for example, high-power operation may be in effect during the first few months of the year, and low-power operation will be in effect the remainder of the year.

3. Explore Our Potential Resources to Increase the Production of C^{60}_o.

With the HFETR in operation, a matching production line of C^{60}_o with annual productivity of 1 million curie has been constructed; it includes two large rooms with a capability of producing 100,000 curie, and a modular laboratory with a 100,000-curie inverted source. These facilities have provided a large number of high-quality products for China's medical, industrial, agricultural, and scientific applications in recent years. To satisfy the needs of the four modernization program, C^{60}_o is being used extensively in

such areas medicine, food processing and preservation, polymer modification, and industrial inspection of defects; as a result, the current supply of cobalt cannot meet the demand. One may ask why not install additional cobalt targets in HEFTR? The answer is simply that additional colbalt targets require additional uranium fuel elements which are very expensive. Therefore, a balanced approach must be taken.

The Osiris Reactor of France has six compensation rods and its backup reactivity is 15.6 percent. The compensation rods are made of small cobalt plates packed in a metal container; the colbalt plates can be retrieved after certain period. The HFETR in this country operate mostly under small load conditions without reactor circuits. The reactors also have six compensation rods and the backup reactivity is also around 15 percent; the useful neutrons are absorbed by the Ag-In-Cd compensation rods. Based on the operation of these reactors, two of the rods remain in the active region 75 percent of the time; therefore, these two rods can be converted to cobalt rods.

4. Promote Research on Low Concentration Fuel for HFETR.

There is currently a wide-spread trend in other countries to study the use of low-concentration uranium as the primary source of reactor elements. It is predicted that by 1986, most reactors will be modified to use low-concentration uranium. In this country, the high cost of fuel elements is the main limitation for further utilization of reactors; therefore, future efforts must be centered around reducing costs. However, whether it is possible to achieve cost reduction is a controversial issue; [the table below] shows a comparison of the operating costs between high-concentration and low-concentration uranium. The calculation took into account such factors as the price of high and low concentration uranium, the manufacturing cost, the transportation cost of needed components, and the post-treatment cost (for instance, more complete burning of the elements can reduce the number of times of post treatment).

Table. Comparison of the Economy of High-Concentration and Low-Concentration Uranium Cores for a 10 Megawatt Research Reactor.

Type of fuel	U-Al Alloy	UAl_x-Al	U_3O_8-Al	U_3Si-Al	U-ZrHx	UO_2 plate
Concentration %	93	20	20	20	20	6.5
Geometric Shape of Element	Plate	Plate	Plate	Plate	Rod	Plate
Operating cost (per MW, in 1000 U.S. dollars)	155	176	133	114	128	172-287

It can be seen from the table that an outstanding fuel type is the aluminum base uranium silica, whose operating cost may be reduced by a factor of 30 percent. Some organizations in this country are already doing research in the manufacturing technology of uranium-aluminum base diffuse fuel plates; they indicate that such technology has already reached a mature level. As mentioned in the previous section, in the process of changing to low-concentration elements in other countries, the geometric shape of the elements essentially remains the same. Thus, the problem is considerably simplified because all the tools used in reactor physics, thermal hydraulics, control, and operation remain unchanged. However, the HFETR in this country uses tubular type elements. Therefore, it is suggested that research efforts be initiated to study the manufacturing of tubular type U_3Si-Al elements; Also, radiation experiments should be carried out and economic analysis based on China's current conditions should be performed. Furthermore, the current fuel element technology is to use joint-pressed ribbed tubes; each tube has three positioning ribs. The presence of ribs lowers the productivity of the elements (raises the cost), and leads to increased core thickness beneath the ribs. The current trend in other countries is to build joint-pressed rib-less tubes. It is suggested that this new technology should be considered as part of the effort of switching to low-concentration uranium elements.

3012
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WINGTIP SAILS TESTED ON Y-5 AIRCRAFT

Beijing GUOJI HANGKONG [INTERNATIONAL AVIATION] in Chinese No 5, May 85 pp 2-3

[Article by Yang Daxi [2799 1129 8408]]

[Text] In recent years, much attention has been given to the use of wingtip ailerons or wingtip sails to reduce induced drag because for most transport airplanes, the induced drag at cruising speed is approximately 30 percent of the total drag; at lower speeds the ratio is even higher. For the Y-5 bi-plane, the induced drag to total drag ratio is approximately 55.6 percent, at cruising speed the ratio is approximately 33 percent, and during climb it is 58 percent. Therefore, wingtip ailerons or wingtip sails potentially can be very effective in reducing the overall drag of the aircraft. Since a large number of Y-5 airplanes are used in this country for a variety of applications, a research program was initiated in August 1982 to install and test wingtip sails on the Y-5 aircraft.

Design and Installation of Wingtip Sails

Based on foreign wind tunnel and flight test results, and taking into consideration the design features of the Y-5 aircraft, we have designed a sail with the geometric shape shown in Figure 1. The length of the sail is 24.5 percent c(wing chord), the base chord length is 16 percent c, and the leading edge backsweep is 21°. In order to delay flow separation at the base, the forward section of the sail has a large camber and twist, so that the flow along the entire chord length of the base gradually turns in the free stream direction, thereby minimizing the peak value of the pressure distribution. Therefore, the mean chord of each cross section of the sail is a circular arc; and when the angle of attack of the wing is positive, the tangent to each mean chord at the leading edge of the sail approaches the local flow direction. Based on results of experimental optimization, we have selected the subtended angle between the tangent lines of the leading edge and trailing edge at the base to be 20°. This angle decreases sharply with increasing distance from the base (for an increase in distance corresponding to 6 percent of the wingtip chord length, the angle decreases by approximately one half); thus, the camber and twist of each cross section of the sail decreases from the base toward the tip. The airfoil type of the sail is NACA 0012. Test results show that best results of induced drag reduction are obtained by using three pieces of sails; increasing the number of sails further provide very little additional

advantage, and lead to higher structural weight. Therefore, on each of the wingtips of the Y-5 aircraft are installed three sails. The leading edge of the forward sail is located at 36 percent c from the leading edge of the wing. Relative to the plane of the wing chord, the forward sail has a dihedral of 30°, the mid sail has a dihedral of 15°, and the aft sail has an angle of 0°. Such a configuration can change the local flow direction, straighten the vortex flow around the wingtip into nearly straight stream lines, and generate a thrust component. The sails are rigidly attached to a 2.18m long cylinder; the tail end of the cylinder is tapered in the form of a parabola. The cylinder is attached to the wingtip in a "glove" con-figuration; its axis is parallel to the wing chord, and 63 mm higher than the wingtip chord line. The layout of the sails on the aircraft wing is shown in Figure 2. The wing configuration with the sails installed is shown in Figure 3.

Flight Test Results

Since October 1982, we have conducted flight tests on the No 8077 Y-5 air-craft with and without the wingtip sails. They included tests under the following conditions: take-off, climb, high-speed level flight, cruise, 45°-slope flight, drift, loss of speed, side slip, glide, low altitude pull-up, and landing. To evaluate the fuel savings, we also conducted repeated flight tests between Shanghai and Hefei. Considering the fact that the reduced strength of the wingtip vortices may improve the uniformity of the sprayed materials and reduce the scattering area, we have also conducted numerous tests of powder and liquid sprays.
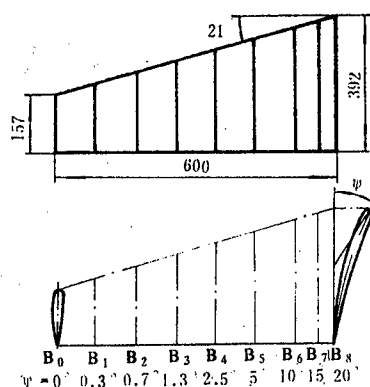
Figure 1. Geometric Features of the Wingtip Sails
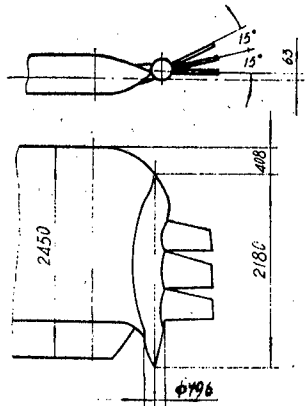
Figure 2. Layout of the Sails on the Aircraft Wing
(units are in millimeters)

Figure 3. The Y-5 Aircraft Equipped With Wingtip Sails

The results show that the use of wingtip sails indeed improved the performance of the Y-5 aircraft. Under the conditions of a gross weight of 4,740 kg, cruising speed of 200 km/hr, and lift coefficient of 0.3436, the wingtip sails reduced the total drag by 4.31 percent, and the induced drag by 22.8 percent.

In the following table, flight test results are presented by converting the data to standard atmospheric conditions. It shows that under full load conditions (5,250 kg), the climb rate is increased by 29 percent, a significant improvement.

51

Table. Improvement in the Performance of the Y-5 No 8077 Aircraft Equipped With Wingtip Sails

Aircraft 8077	W = 4000 kg Degree of improvement		W = 5250 kg Degree of improvement	
	Increase (%)	Decrease (%)	Increase (%)	Decrease (%)
Maximum level-flight speed	1.8		1.9	
Cruising speed	2		2.4	
Rate of climb	8.7		29	
Climb time		8		22.5
Glide rate		11.1		8.3
Glide time	12.4		9.1	

Flight test results also show that the ceiling of the aircraft increased by approximately 1,000 m after installation of wingtip sails. This is very important for operation over high elevation terrains. According to performance calculations, under cruise conditions, if the horse power parameters are kept unchanged (i.e., engine speed 1,700 rpm, intake pressure 700 mm Hg), the use of wingtip sails can result in a fuel saving of 2.0 percent; if the cruising speed is kept unchanged, a fuel saving of 4.58 percent can be achieved. Flight test results show that the former is 2.5 percent and the latter is 5.1 percent, both of which exceed predicted values. The spray tests also show that with wingtip sails installed, the area of coverage is increased and the sprayed materials are lower and more uniform. Figure 4 shows the measured overall uniformity of sprayed particles during three spray tests with and without wingtip sails.
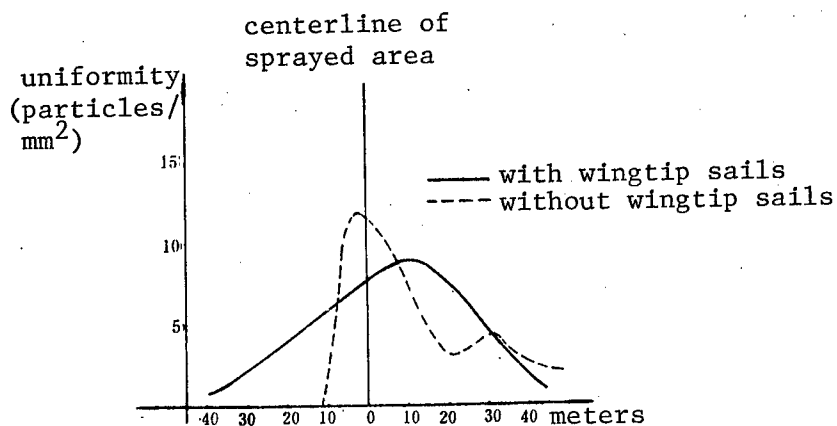
Figure 4. Overall Particle Uniformity During Three Spray Tests With and Without Wingtip Sails on the No 8077 Aircraft

In addition, according to reports from the test pilots, the aircraft equipped
with wingtip sails is easier to maneuver, more responsive, and is more stable
and easier to control during steep glide or sideslip flight. Since April
1983, the No 8077 aircraft equipped with wingtip sails has flown over 320
hours during routine flights, training flights, and actual operations. It
has been shown that the improvement in flight performance is in agreement
with flight test results. In November 1984, wingtip sails were installed on
another Y-5 aircraft, No 8242, which had passed the certification flight
tests of the Civil Aviation Bureau, and thus convincingly proved the effec-
tiveness of wingtip sails.

3012
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TRENDS IN PHARMACOLOGY DISCUSSED

[Article by Zhou Jinhuang [0719 6855 7806], of the Institute of Pharmacological and Toxicological Research, the Military Academy of Medical Sciences, Beijing: "Trends in the Development of Pharmacology in China"]

[Text] I. Characteristics of Pharmacological Development in China

China is a nation with an ancient cultural tradition that has made many major pioneering contributions to human civilization and progress. Our study of medicine and pharmacy is one of these. For several millenia traditional Chinese medicine and pharmacy formed an independent, integrated philosophical and ideological system of their own that guided the clinical practice of medicine and pharmacy in China. Over a very long period of time traditional Chinese medicine and pharmacy continued to advance and develop, absorbing a great quantity of drugs from abroad in its international contacts. These supplemented our drug sources and enriched our traditions. Particularly in the past few decades, traditional Chinese medicine and pharmacy has coexisted with modern medicine and pharmacy, each permeating the other, and this has brought progress to traditional Chinese medicine and pharmacy. This is the developmental foundation and background of modern pharmacology in China.

Since Western medicine was brought into China it has produced an enormous transformation in the development of medicine in China. Western medicine and pharmacy occupy a distinctly dominant position in China's medical, pharmaceutical and health facilities. In the wake of the growth of modern natural sciences, medicine and pharmacy, we should continue to strengthen and pay close attention to the development of modern pharmacology.

The state of development of traditional Chinese medicine and pharmacy facilities has obviously progressed since the initial period after the founding of the People's Republic of China, but generally speaking our development has been slow, manpower has been weak and the level has been low. Compared with Western medical and pharmaceutical facilities, there is a definite disparity. From a historical and background perspective there have been extremely advantageous conditions for pharmacological research into traditional Chinese medicine, but, following from the complex demands of modern

science, there have also been many more difficulties by comparison with pharmacological research into synthetic medicines. Consequently, pharmacological workers in China bear dual responsibilities: on the one hand they must catch up to the level of contemporary international pharmacology, and at the same time they must strive to improve the level of traditional Chinese pharmacology. This will allow pharmacological development in China to have a Chinese character, and it will form a consistent and integrated Chinese and Western pharmacology.

II. Major Progress in Modern Pharmacology

From the perspective of pharmacological development, 20th century pharmacology can be divided into two stages. The prominent development in the first half of the century was the growing independence of pharmacology from clinical medicine and therapeutics and its establishment as one major branch of basic experimental medical science. Physiology, pharmacology and pathology helped each other forward and laid a foundation for modern medicine. They developed the new substance of microbiological medicine and by degrees intensified into a new molecular-level discipline. However, they correspondingly neglected the whole, complete nature of the human being and the integrated functions of his various systems, so that experimental pharmacology and clinical therapeutics nearly lost touch with each other. Since the 1950's the prominent development in pharmacology has been a new stage of integration with clinical medicine and the emergence of clinical pharmacology. In the past 30 years clinical pharmacology has grown rapidly and an intimate relationship has grown up between basic pharmacology and clinical applications. In addition the mutual integration of clinical pharmacokinetics and clinical pharmacodynamics has guided the program for clinical drug use. This turning point in the history of pharmacological development points out that we should reappraise China's pharmacological education and scientific research program so that pharmacology will further develop toward clinical application. In order to spur the development of clinical pharmacology, pharmacological education is imperative. Pharmacology should be divided into basic pharmacology and clinical pharmacology, and there should be a further differentiation between educational grades so that the pharmacological contingent in China will be further specialized.

1. The Integration of Clinical Pharmacokinetics and Clinical Pharmacodynamics

Within pharmacological research in China, work in pharmaceutical metabolic dynamics was launched rather late and there are not many pharmacological personnel engaged in work in this area. At present the emphasis is on studying drug distribution, absorption, excretion and blood concentration within the bodies of animals, whereas clinical pharmacokinetic research is very meager. There is quite an obvious difference between animals and human beings in terms of pharmacodynamics, yet some regular patterns of pharmaceutical effects in humans have already been worked out by inference from animal experimentation. Drugs with different types of chemical structures have different patterns that they may follow, but ultimately they must still undergo clinical pharmacodynamic research and observation. In pharmacokinetic work the differences between animals and human beings are even more obvious. At present

we have not yet accumulated sufficient data from animal experimentation to infer regular pharmacokinetic patterns for human beings. Consequently, the development of clinical pharmacokinetic research should be the major order of the day in clinical pharmacology.

Pharmacokinetic research should be integrated with pharmacodynamic analysis because pharmacokinetics is one of the major foundations aiding clinical physicians in their assessments of pharmacodynamics. The determination of drug concentrations in a patient's blood is significant for guiding the use of drugs in clinical treatment. Right now this is considered to be an indispensable index.

2. New Drug Discovery and Evaluation

In this century, pharmacology and pharmacochemistry have cooperated closely and developed hundreds of specific drugs. This has made an enormous contribution to clinical medicine and experimental research, and is one of the most prominent achievements of modern pharmacology. Pharmacology has already developed away from studies of the active mechanisms of known drugs, toward a new phase of emphasis on research into new, unknown drugs. Development of a new drug begins with laboratory research, develops into preclinical research and later proceeds to clinical trial studies. Finally, it undergoes a new drug assay, observation of clinical application is expanded, experimental data is supplemented and long-term clinical safety and curative effects are evaluated. New drug development is a burgeoning enterprise association of the chemical industry and medicine. According to statistics from outside of China, development of a single new drug of clinical value requires a great deal of manpower, technical equipment, scientific supervision and economic information. In addition, it costs 10 million yuan and must undergo many years of study before it can be selected from among a large number of chemical compound candidates. In capitalist nations the discovery of new drugs is already undertaken primarily by pharmaceutical plant research institutes, with university pharmacological and pharmacochemical teaching and research sections and clinical hospitals playing supporting roles.

The source of new drugs is primarily synthetic drugs: thousands of new compounds can be synthesized annually. Pharmacology labs in pharmaceutical plant research institutes conduct all sorts of biofunction screening studies on new chemical compounds in an attempt to discover prominent new functions among them. According to many years of experience in England, the United States and other nations, of 5,000 to 10,000 new chemical compounds, pharmacological screening and initial toxicity determinations weed out all but maybe 10 of them that reach the trial candidate phase and are immediately entered into preclinical research. Of these 10, there may be 1 that is selected which achieves the safety requirements and curative appraisal level for a new clinical drug and can be put into production and tried out in applications on an expanded scale. In Europe, the United States and other nations there may be tens of new drugs each year. According to recent statistics from England (from the early 1980's) there are 15-20 new drugs that can be marketed each year. From initial research to establishment as a new drug that is advantageous to pursue, each drug costs an average of 17 million

pounds (approximately 35 million dollars). The pharmaceutical plant must make a great effort at publicity if it seeks to reap high profits within the patent period (generally 10 to 15 years). Otherwise, there is strong competition in the market for new drugs, the rate of competitive elimination is high, the new drug cycle is short and there are circumstances like the fashionability of competitive development to consider.

Our pharmacological workers should not pursue new drugs blindly; they must both acquaint themselves with reports on pharmacological functions and clinical effectiveness in various areas, and they must also analyze defects to make an objective and reasonable appraisal. The number of good, truly tenable new drugs is quite small, and each without exception has its own characteristics.

Based on our own reported experiences and literature, research into new drugs demands coordination among many areas. Abroad, pharmaceutical sources come from many areas. In addition to synthetic drugs, in recent years there has also been a great emphasis on botanical and biological drug sources, including active peptides, polysaccharides, bacteria and vaccines. Purposes differ for the development of Chinese traditional medicines abroad. Japan attaches significant importance to traditional Chinese medical prescriptions and tends to vie strongly with China in the international market for them. Some nations study Chinese drugs as natural botanical products, and their achievements have not been at all prominent. China's development of traditional medicines embodies both the aspect of inheritance and that of the development of new drugs. According to reports, in the past 35 years an average of 2 to 5 kinds of new drugs have been marketed annually. This is vastly inferior to the success rates abroad, yet these achievements have not come easily. In the wake of an increase in China's scientific research personnel and a gradual improvement in their level, our new drugs, particularly those developed from traditional Chinese medicines, will proliferate.

The supply of drug sources depends upon pharmacochemistry (synthetic chemistry), phytochemistry (for extracting generally effective components and monomers) and analytical chemistry (to determine component specifications). At the same time, new pharmaceutical trends, intelligence data and analysis, market news and patent information on similar drugs must be taken into consideration in order to decide whether to invest in research and set up a research program. In large, modern pharmaceutical plants experimental pharmacological research is conducted separately in certain research labs. For example, general studies of pharmacological effects, toxicology and pharmacodynamics; pathologic model studies; and specialized research into such areas as antibiotins, antiparasitics and immunity are conducted separately. Some pharmacological studies of new synthetic drugs follow a set screening plan and some screen for similar universal properties and apply tens of indices to the task. Directed screening and extensive screening both require a search for new types of compositions that are low in toxicity, strong-acting and have concentrated curative effects. Generally speaking, new drugs must possess certain outstanding properties such as low toxicity and low production costs. When compared with known drugs, if the new drugs

57

can be used as substitutes they can become candidate drugs. New drugs that lack obvious advantages can all be eliminated.

If a new drug indicates a transitional nature in preclinical studies, it is both plunged into substantial experimental research and preparatory clinical research is launched simultaneously. This stage may be long or short, but gradually develops toward clinical applications. Now every nation has various rules and restrictions concerning new drugs. We believe that we should have new-drug development stipulations that conform to China's realities. There should be differences between the requirements for synthetic drugs and for traditional Chinese medicines.

3. Progress in Combined Chinese and Western Medical Research on Traditional Chinese Medicine

Research into traditional Chinese medicine has a distinctive style by comparison with research into synthetic drugs or Western medicine. Traditional Chinese medicine is good medicine that has undergone repeated screenings and comparisons by skilled clinical doctors and apothecaries through many years and successive dynasties and has been retained and passed down to us by our forefathers. Although China boasts many varieties of traditional prescriptions, they are without exception classically renowned for their originality: this is the precious heritage of our nation. The clinical curative effects and usefulness of traditional Chinese medicine has long been confirmed. This is a favorable factor that is not shared by research in synthetic drugs or bioactivated natural drugs. The study of Chinese medicines can neither disregard traditional experience nor should it be constrained thereby. Our research goals are to develop traditional Chinese medicine, make it more beneficial to the national economy and the people's livelihood, improve its curative effects, expand the objects and range of its uses and improve the modern scientific level of Chinese medicine and pharmacy. In the past few years we have achieved many notable successes, and some of the experiences are worth expanding upon. The example of the traditional Chinese medicine cattail pollen and prescription laughing powder will illustrate the advantages of combining Chinese and Western medicine to study traditional Chinese medicines:

Chinese laughing powder is an effective prescription composed of two medicinal ingredients, cattail pollen and Trogopterus dung, used for invigorating vital energy and blood circulation, as well as for curtailing various pains. Since the Tang and Song dynasties it has been recorded by skilled doctors and scholars of Chinese materia medica (in the "Hejiju Fang" [Dispensary Prescriptions] of the Yuan dynasty and the "Bencao Gangmu" [Compendium of Materia Medica] of the Ming dynasty). The 1977 edition of the "Zhongguo Yaodian" [Pharmacopoeia of China] also lists it as a commonly used prescription. The most recent edition (1983) of the "Zhongyao Yaoli Yu Yingyong" [The Pharmacology and Applications of Traditional Chinese Medicine] enumerates in detail the multifaceted pharmacological actions and clinical curative effects of cattail pollen and laughing powder.

Since the 1970's the extensive nationwide development of research into prescriptions for drugs to prevent and treat coronary heart disease and hypertension has achieved great success. The theoretical basis for this is the holistic diagnosis by traditional Chinese medicine that angina pectoris in coronary heart disease belongs to the category of "chest obstructions" and "heart pains," usually arising from "blood stasis due to stagnation of vital energy" and treated according to the principle of "vital energy normalization and blood invigoration." In clinical practice at various locales workers in combined Chinese and Western medicine separately compounded many new complex prescriptions that had relatively high curative effects. Step by step they refined various monomers with excellent effects, such as Radix Salviae Miltorrhizae ketones, Rhizoma Ligustici Chuanxiong piperazines, Radix Salviae Miltorrhizae elements and so forth. Some units (in Shanghai and Changsha) separately studied laughing powder and cattail pollen, discovered that they are distinctly effective against cardiovascular disease and verified their pharmacological effects on animal pathologic models. The Hunan Institute of Traditional Chinese Medicine continued the probe and discovered a component in cattail pollen extract that lowers plasma cholesterol and reduces triglycerides, as well as a component that protects the blood vessels of the heart and prevents zhouyanghua bingbian [4728 2876 0553 4016 6239]. These research achievements (of which a corresponding portion have not yet been reported, as some still require continued intensive research) have brought Chinese pharmacology, pharmacochemistry and biochemical pharmacology, as well as clinical pharmacology and clinical therapeutics, to an advanced international level in the field of anti-hyperlipoidemia research. They are highly effective, low in adverse reactions, convenient and easy to use. These achievements have relatively numerous advantages when compared with the Western drugs niacin and clofibrate ethyl p-chlorophenoxysobutyrate (atromid-S) that are now being appraised in the literature abroad.

In addition to lowering blood-fat, cattail pollen also increases the quantity of blood flow in the coronary artery, augments anti-myocardial ischemia and anoxia endurance functions, lowers blood pressure, lowers peripheral vascular resistance and improves circulation. These effects are beneficial in the treatment of coronary heart disease and other cardiac vascular diseases. The effects of cattail pollen are multifaceted: it has an antioncotic effect on experimental arthritis, and it also has the effect of suppressing the immune functions, lowering the rates of thrombocytic adherence, lengthening the clotting time and so forth. This supplies a pharmacological foundation for traditional Chinese medicine with respect to "blood normalization and blood stasis." Thus it can be seen that traditional Chinese medicine has come to recognize the properties of Chinese drugs through a long period of clinical practice. These "medical properties" embody the concept of pharmacology. The ancients were good at summarizing and inducing medical properties and holistic clinical diagnoses, and modern medicine verifies on many fronts that their generalities are scientific.

To sum up, through research in combined Chinese and Western medicine, experimental pharmacology and clinical pharmacology and therapeutics are integrated together, phytochemistry is integrated with pharmacochemistry and pharmacology and studies of compound prescriptions are integrated with studies of

single ingredient drugs. In particular, the simultaneous implementation of research in traditional Chinese pharmacology and in clinical effects is the most efficacious research path. This path has not only been completely positive with respect to research on cattail pollen, but it has also been affirmed in studies of many traditional Chinese drugs in recent years and in its adherence to the process of integrating traditional Chinese and Western medicine. Hereafter, in our research on traditional Chinese medicine we will see a new phase of mutual permeation between it and research on new drugs. The background for this is vast, and China's pharmacological workers can carry on and continue to enhance the precious intellectual wealth of our ancestors. This is an undertaking which makes us proud.

12510
CSO: 4008/332

BRIEFS

MORE DRUG INSPECTORS URGED--Beijing, July 1 (XINHUA)--Public Health Minister
Cui Yueli has called on all local authorities to set up inspection agencies
to implement strictly the new pharmaceutical management law which takes
effect from today. At present, only 800 of China's 2,100 county authorities
have such inspection teams. In an article in Sunday's "Health News" daily,
Cui said the establishment of agencies at various government levels was
vital if the new law was to be effective in protecting the public from
poor medicines. He also called on the industrial and commercial
administrative, legislative, and trade departments to monitor the
implementation of the law. Meanwhile, the XINHUA commentator commented
that the quality of pharmaceuticals must be guaranteed, and anyone making
or selling shoddy medicines must be punished. [Text] [Beijing XINHUA
in English 0819 GMT 1 Jul 85]

5300/12

TITLES OF SELECTED PAPERS FROM THE SIXTH NATIONAL CONFERENCE ON INFRARED SCIENCE AND TECHNOLOGY

Shanghai HONGWAI YANJIU [CHINESE JOURNAL OF INFRARED RESEARCH] in Chinese Vol 4, No 2, Apr 85

[Text] A. Searching and Tracking (16 papers):

A1 Development of Modulating Frequency Infrared Tracking and Sounding System
by Shi Meiyao [0670 5019 5069]

A2 Analysis of Phase Frequency Characteristics in Intermediate Links of Modulated Amplitude Type Infrared Angle Tracking System
by Hu Gongxian [5170 0501 6902]

A3 Study of Interference Noise of Optical Tracking Gyroscope System
by Chen Zujin [7115 4371 6855]

A4 Interference and Restraint on Infrared Search System
by Sun Shaoyou [1327 1421 0645]

A5 Design and Application of Mangin Mirror in Infrared Tracking Optical System
by Yu Yanfang [0827 1177 5364]

A6 Selection of Spectral Wave-Band of Middle Infrared Guidance Head
by Lu Mingyi [0712 2494 5030]

A7 Characterization Parameters of Single-Channel Infrared Guidance System
by Zhou Xiaodong [0719 2556 2639]

A8 Testing of Static Parameters of Infrared Tracking Device
by Xu Zhongren [6079 0112 0088]

A9 Infrared Simulation System   by Wang Jianji [3769 1696 1015]

A10 Characteristics of Simulation, AGC and Phase-Amplitude of Infrared Signals--Application of Integrated Multiplier in Infrared Tracking System
by Zhong Junyi [6945 0193 5030]

A11 Consideration of False Alarm Rate and Wave Form Conversion Coefficient in Infrared Tracking System   by Ye Feng [5509 2800], Xue Tianzhu [5641 1131 2691] and Jiang Yanfa [1203 1693 4099]

A12 Development of Low Noise Amplifier in Infrared Tracking Device   by Gui Yonghua [2710 3057 5478]

A13 Principle and Application of Automatic Search by Gyroscope Guidance Head   by Yang Jisheng [2799 0679 5116]

A14 Problems in Image Guidance   by Yang Yihe [2799 1355 4421] and He Bin [0149 3453]

A15 Interference and Suppression of Noise in Small Infrared Guidance Head   by Li Jinze [2621 6855 3419] and Liu Guizhi [0491 2710 2655]

A16 Study on Enhancing Error Characteristics of Infrared Conical Scan System   by Jin Tongluo [6855 2717 2867] and Kang Dajing [1660 1129 4842]

B. Infrared Imaging (21 papers):

B1 Determination of Parameters of Probe in Infrared Optical Device Scanning System   by Zhang Dexin [1728 1795 2946]

B2 Consideration in Design of Infrared Thermal Imagery System   by Zhang Ronghua [1728 2837 5478]

B3 New Application of Optical Computation Program of Nonspherical Noncoaxial System   by Zhao Xiuli [6392 4423 7787]

B4 A Frame Raster of Optical Thermal Imagery Instrument   by Li Yi'an [2621 5030 1344]

B5 Analysis of Reference Bandwidth and Sensitivity of Parallel Scan Infrared Imagery System   by Zhang Xiaolin [1728 1321 7207] and Shu Yuwen [5289 6735 3429]

B6 Development of Microcomputer System of Thermal Imagery Instrument   by Yu Qihua [6735 0796 5478]

B7 Simulation Real-Time Processing of Images by Thermal Imagery System   by Zhang Wensen [1728 2429 2773] and Zhang Xiaolin [1728 1321 7207]

B8 Linear, Nonaxial Out-of-Focus Convergent Beam Scanner   by Zhao Jiaqi [6392 1367 3825]

B9 Theoretical Calculations of Optical Scan System in Infrared Thermal Imagery Instrument   by Hu Yuxin [5170 5148 2946]

C. Infrared and Multispectral Remote Sensing (19 papers):

C1 Application of Multispectrum Scan Images in Remote Sensing Test at Tou
River Reservoir   by Li Chengzun [2621 2052 1415], Wang
                                  Zhimin [3769 1807 3046] and Li Jinghua
                                  [2621 2529 5478]

C2 DGS-1 Type Aviation Multispectrum Scanner
                                  by Xue Yongqi [5641 3057 3825], Sun
                                  Jixiu [1327 4480 0208] and Wu Changyong
                                  [0702 1603 3144]

C3 Small Multispectrum Scanner   by Zhang Renchu [1728 0088 0443]

C4 Reception Sensitivity and Orbit Selection of Satellite-Borne Multispec-
trum Scanner   by Gu Yonghua [7357 0516 5478]

C5 Satellite-Borne Multichannel Infrared Radiometer
                                  by Chen Yuewu [7115 6460 2976], Xiang
                                  Shaojun [0686 4801 0689], Ma Yanhua
                                  [7456 1693 5478], Nan Jiafu [0589 1367
                                  4395], Xu Xiujuan [1776 4423 1227] and
                                  Li Jihong [2621 4949 4767]

C6 10.6μm Astronomical Heterodyne Spectrometer
                                  by Yu Yinshan [0151 0692 1472]

C7 Design of Simulation Circuit in Infrared Spectrometer
                                  by Wang Mochang [3769 2307 2490]

C8 Data Collection and Control System for Radiation Target Acquisition of
Satellite-Borne Infrared Remote Sensing Instrument
                                  by Gong Huixing [7895 1920 1472], Zhang
                                  Jianxin [1728 1696 2450] and Li Liangxin
                                  [2621 5328 2450]

C9 Application of Single-Board Microcomputer on Infrared Spectrometer
                                  by Wang Mochang [3769 2307 2490]

C10 Design of Oscillating Mirror in Satellite-Borne Multispectrum Scanner
                                  by Qian Honglin [6929 7703 7792], Ji
                                  Meidi [1323 5019 1229] and Liu Zhengxing
                                  [0491 2973 5281]

C11 Design and Adjustment of Dynamic Equilibrium of 45° Rotating Scanning
    Mirror   by Wang Genbao [3769 2704 1405] and Hao
                                  Jingyu [6787 2529 3842]

C12 Determination of Characteristic Parameters of Infrared Multispectrum Row
    Scanning Imagery System   by Huang Keyi [7806 0344 5030] and Chu
                                  Jiadong [5969 1367 2767]

66

E. Others (11 papers):

E1 Radioactivity Calibration of Absolute Spectrum of Visible Light--Near
    Infrared Integrating Sphere   by Ye Jiafu [5509 1367 4395]

E2 Digital High Precision Dynamic Micrometry System
                                by Liu Shang'gan [0491 0006 0051] and
                                Li Kun [2621 3824]

E3 Study of Infrared Heterodyne Characteristic of N$^+$-P Type HgCdTe Photo-
    electric Diode   by Fang Hubao [2455 3275 1405], Zhang
                                Xianchi [1728 7359 3589] and Cai Shidong
                                [5591 1709 2639]

E4 Discussion on Problems in Low-Impedance Amplifier
                                by Jin Zhiyu [6855 1807 3558]

E5 Computing Amplifiers Used in Infrared Primary Amplifier
                                by Bai Shuhua [4101 3219 5478]

E6 Design of High-Order Multiresonator Bandpass Filter
                                by Kong Musheng [1313 3092 3932]

E7 Zero Frequency Normalization of Infrared Transfer Function Instrument
                                by Feng Zhuoxiang [7458 0587 4382] and
                                Liu Zhongben [0491 0022 2609]

E8 Comments on "Revision on Sensitivity Equations of Various Infrared Sys-
    tems"   by Chen Lixin [7115 4539 0207]

E9 Spectrum Testing System of Infrared Wave Segment
                                by Zhou Zuoping [0719 0146 1627], Zhang
                                Xiaomin [4545 1420 3046] and Li Wenhong
                                [2621 2429 4767]

E10 10μm Near-Earth Atmospheric Communication System by Use of Thermal Re-
    lief Electric Sounding Device   by Hu Yu [5170 3254]

E11 Frequency Compensation in Noise Analysis for LiTaO$_3$ Device in High Fre-
    quency Wideband High Power System
                                by Hu Yu [5170 3254]

AUTHOR: YANG Jihua [2799 4949 5478]
          PANG Shufen [6614 2631 5358]
          SUN Tao [1327 3447]
          et al.

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Stereospecific Polymerization of Butadiene Catalyzed by
NdCl$_3$·2Phen-HAl(i-Bu)$_2$ System"

TEXT OF ENGLISH ABSTRACT: A new binary rare earth chloride catalyst composed
of NdCl$_3$·2Phen(Phen = 1, 10-phenanthroline) and HAl(i-Bu)$_2$ for stereospecific
polymerization of butadiene is presented. In contrast to other types of rare
earth chloride catalysts, the present system is characterized by its ability
to control the molecular weight of the product and its specific mode of
formation. The general rule of butadiene polymerization with the catalyst
was studied. It was found that HAl(i-Bu)$_2$ is mainly the chain transfer agent
in the reaction and the HAl(i-Bu)$_2$/monomer ratio is a key parameter controlling
the molecular weight of the polybutadiene obtained. The possible role of the
phen molecule in molecular weight controlling is discussed.

AUTHOR: NI Yushan [0242 3768 1472]
            XU Jiping [1776 4764 1627]

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Synthesis of Azoxybisbenzocrown Ethers"

TEXT OF ENGLISH ABSTRACT: Two new azoxybisbenzocrown ethers were synthesized. The preparative method of azoxybisbenzo-15-crown-5 has been improved, with a yield of up to 65.3 percent. It was observed that the degree of dissociation of the electron-transfer agent plays an important role in the product yield. The results were interpreted in terms of solvent polarity. Photo- and thermo-isomerization of azoxybisbenzocrown ethers have been studied preliminarily.

AUTHOR: ZHAO Xingfa [6392 5281 4099]
          YANG Dezheng [2799 1795 2973]
          ZHANG Li [1728 0500]
          CHEN Xiuhua [7115 4423 5478]
          et al.

ORG: ZHAO, YANG, et al., of the Institute of Dalian No 7 Petroleum
Refinery; ZHANG, CHEN, et al., of Dalian Institute of Chemical Physics,
Chinese Academy of Sciences

TITLE: "A Viscosity Index Improver for Lubricating Oil from Ethylene-
Propylene Copolymer"

TEXT OF ENGLISH ABSTRACT: A highly active supported catalyst $(TiCl_4-PCl_3)/$
$MgCl_2-AlEt_3$ for ethylene-propylene copolymerization is reported. An ethylene-
propylene copolymer with low molecular weight and narrow molecular weight
distribution has been obtained through the addition of PCl_3 ligand in the
catalyst system and the hydrogen regulation during the reaction. The
copolymer is suitable for improving the viscosity index of lubricating oil,
since it has rather good overall properties, such as viscosity index,
thickness, low temperature viscosity, and is stable against shearing,
oxidation, heat, etc.

AUTHOR: HU Ninghai [5170 1337 3189]
LIN Yonghua [2651 3057 5478]
ZHOU Qinglian [0719 3237 1670]
et al.

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Crystal Structure of Potassium Europium Metaphosphate"

TEXT OF ENGLISH ABSTRACT: The potassium europium metaphosphate crystal
$KEu(PO_3)_4$ belongs to the monoclinic space group $P2_1$ with unit cell parameters
$a = 7.932(4)$Å, $b = 8.375(1)$Å, $c = 7.261(3)$Å, $\beta = 92.05(4)°$, $V = 482.0$Å^3, $Z = 2$.
The intensities of 979 independent reflections were collected by the PW-1100
four-circle diffractometer. The structure was solved by the heavy-atom method
and the final $R = 0.084$ after refining by the full-matrix least-squares
method. The basic structural units are helical ribbons, $(PO_3)_n$, formed by
corner sharing tetrahedra of PO_4. The coordination of the europium anion by
oxygen atoms is eight-fold with the geometry of dodecahedra. The shortest
Eu-Eu distance is 6.93Å.

AUTHOR: XU Yang [1776 3152]
YU Fusheng [0151 6346 3932]
ZHOU Enle [0719 1869 2867]
et al.

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "On the Relationship of Molecular Weight and Temperature with the Crystallization Behavior of cis-Polybutadiene"*

TEXT OF ENGLISH ABSTRACT: It has been shown that cis-1,4-polybutadiene obtained by a rare earth catalyst (Ln-PB) possesses a cis-1,4-content higher than 98 percent, and can be crystallized rapidly at low temperatures. This paper presents our study on the relationship of molecular weight and temperature with the crystallization behavior of Ln-PB using a dilatometer and electron microscope.

A set of crystallization rate curves of Ln-PB is given in this paper. It is seen that the minimum rate of crystallization occurs in the range of $\langle M \rangle_\eta = 4.6 - 6.7 \times 10^5$, while the maximum rate is in the range of $\langle M \rangle_\eta = 3.0 - 3.8 \times 10^6$. The results are interpreted in terms of the nucleus theory of crystallization.

It is also shown that, for Ln-PB, there is a transition at about -20°C from regime I to regime II as the crystallization temperature decreases. The interfacial free energy of Ln-PB, σ_e, is about 17 erg/cm^2 when $\langle M \rangle_\eta < 10^6$, which increases with increasing molecular weight when $\langle M \rangle_\eta > 10^6$.

*Model TQ-16 computer was used for all calculations.

9717
CSO: 4009/1049

AUTHOR: LIN Junmi [2621 0689/33055 1378]
           GAO Mingxia [7559 2494 0204]
           LIU Hengchuan [0491 1854 2976]

ORG: Department of Chemistry, East China Normal University

TITLE: "Studies on the Spectrophotometric Determination of Thorium with
a New Chromogenic Reagent Nitrophosphonazo-mN (NPA-mN)"

TEXT OF ENGLISH ABSTRACT: Nitrophosphonazo-mN 2-(4-nitro-2-phosphonophenylazo)-
7-(3-nitrophenylazo)-1, 8-dihydroxy 3,6-naphthalene disulfonic acid is a new
chromogenic reagent which forms a stable complex with thorium instantaneously
in a strong acidic medium. The color reaction between them takes place
rapidly, having fine contrast and high sensitivity. The value of molar
absorptivity at 665 nm is found to be 1.17×10^5 $1 \: mol^{-1}cm^{-1}$ and $1.62 \times
10^5$ $1 \: mol^{-1}cm^{-1}$ (dual wavelength method). Beer's law is obeyed for 0-30 µg
and 0-35 µg of Th in 25 ml on single and dual wavelength determination
respectively. Twelve parallel determinations of 10 µg of Th give a relative
standard deviation of 2.59×10^{-3} and a coefficient of variation of
0.787 percent.

The outstanding advantage of NPA-mN is its excellent selectivity. The
tolerance of most metallic ions, including Zr(IV), V(V), etc., may reach the
milligram level. The tolerance of those often seriously interferential
elements such as U(VI), RE(IV) and Ti(IV) exceeds that using other analogous
reagents.

A procedure has been worked out for determining Th in tap or river water,
urine and extracting technological waste water of Zr and Hf (without
preparation) with good results. The latter has to be separated preliminarily
by ion-exchange in determination with Arsenazo-III. (Paper received on
27 August 1983.)

AUTHOR: SHI Huiming [0670 1979 2494]
         ZHANG Guizhu [1728 6311 3796]
         AN Zemin [1344 3419 2404]

ORG: Department of Chemistry, Nankai University

TITLE: "Formation of the Mixed Micelle and Its Analytical Application in the Multicomponent Complex-Fe-CAS System"

TEXT OF ENGLISH ABSTRACT: An effective method for increasing the sensitivity and selectivity of color reaction of Fe (III) has been studied because of the excess amount of Triton X-100 added to the system Fe-CAS-DDMAA (HDMAA).

The addition of Triton X-100 would greatly increase the molar absorptivity, widen the useful pH range and allow the presence of many masking agents.

A new method has been successfully developed for the rapid determination of trace amounts of Fe in samples of pure Co, pure Al, pure RE_2O_3, Al alloy, Ni alloy and Cu alloy.

AUTHOR: WANG Changfa [3769 7022 4099]
         LU Jixin [4151 4949 2450]

ORG: Tianjin Institute of Geology and Mineral Resources

TITLE: "Spectrophotometry with Vanadium Phosphomolybdate-Nile Blue Multi-component Complex and Determination of Vanadium in Monomineral Silicate"

TEXT OF ENGLISH ABSTRACT: The properties and application of the vanadium phosphomolybdate-nile blue ion-associated complex are studied. Its color is blue in 2.3 N sulfuric acid. It is more stable in the presence of polyvinyl alcohol. The constituent ratio of vanadium phosphomolybdate to nile blue is 1:4. The complex and reagent have maximum absorption at 570 nm and 630 nm respectively. The complex has a molar absorptivity of 1.3×10^5. Beer's law is obeyed for vanadium in the concentration of 0 to 10 μg/50 ml. In order to eliminate the interference of titanium and silicon, the acidity and the amount of phosphor should be increased when heteropoly acid is formed, and phosphoric acid should be added when the excess of phosphomolybdate is being dissociated by an oxalic acid-tartaric acid-sulfuric acid mixture. Macro amounts of titanium and silicon may exist as tolerable. This method has a high sensitivity and good selectivity. In the analysis of iron or silicate minerals of small amounts, 0.X to 0.00X percent of vanadium can be determined without separation. RSD ranges from 3 to 8 percent. (Paper received on 23 September 1983.)

AUTHOR: CHEN Siqin [7115 1835 2953]
          PENG Shanshan [1756 3790 3790]
          RUAN Dawen [7086 1129 2429]

ORG: Department of Chemistry, Jiangxi University

TITLE: "Spectrophotometric Determination of Trace Amounts of Selenium (IV) by a New Catalytic Reaction"

TEXT OF ENGLISH ABSTRACT: A new catalytic-spectrophotometric method for determining selenium (IV) is proposed. Selenium catalyzes the oxidation of phenylhydrazine by potassium chlorate to diazobenzene-diazonium ion, through which a violet-red azo dye is obtained by coupling with H-acid. Optimum conditions for determining selenium have been established. The sensitivity presented as apparent molar absorptivity equals 1.2×10^6. Trace amounts of selenium in human hair have been determined with satisfactory results. (Paper received on 3 May 1983.)

AUTHOR: FAN Cunzhong [5400 1317 1813]

ORG: Metallurgical Project and Research Institute of Guizhou Province

TITLE: "Spectrophotometric Determination of Gold Based on the Formation of Ternary Complex Au-2, 4, 5, 7-Tetrabromofluorescein-I-Pyrrolidinedithiocarboxylic Acid Sodium Salt"

TEXT OF ENGLISH ABSTRACT: A spectrophotometric method has been developed for the determination of gold based on the formation of ternary complexes of Au(III) with TBF and PDDTC in an aqueous solution in the presence of polyvinyl alcohol. The complex absorbance is measured at 545 nm and the molar absorptivity is 2.56×10^4. Beer's law is obeyed in the range of 0 to 3.2 μg for Au(III) in 1 ml. The composition ratio of Au to ligand is 1:2:2. The color reactions can be applied to spectrophotometric determination of gold in mineral ores or in some other samples. (Paper received on 18 May 1983.)

AUTHOR: WU Runshen [0702 3387 6500]

ORG: Central Laboratory, Huabei Prospecting Company of Metallurgy and Geology

TEXT OF ENGLISH ABSTRACT: A method which combines separation technology and the formation of a multicomponent complex has been drawn up for the determination of Sb in the aqueous phase without organic solvent. Antimony could be separated as hydride from matrix elements in bulk. The complex turned orange in the medium of 0.25 N to 0.38 N HCl, and had maximum absorptivity at 510 nm, with molar absorptivity being 7.1×10^4 $1\ mol^{-1}cm^{-1}$. The content of antimony (0 to 15 μg/10 ml) adhered to Beer's law. The interferences were eliminated with a suitable masking agent and a specific absorbent. The complex would remain stable for three hours at room temperature. This method can be used directly to determine micro antimony in rock and soil in the aqueous phase. (Paper received on 18 May 1983.)

AUTHOR: XUE Guang [5641 0342]

ORG: PLA Unit 00524

TITLE: "Color Reaction of Ternary Complex of Thorium-Semixylenol Orange-Cetyltrimethylammonium Bromide"

TEXT OF ENGLISH ABSTRACT: A color reaction of thorium with semixylenol orange (HXO) and cetyltrimethylammonium bromide (CTMAB) has been investigated, and a successful determination of micro thorium in uranic ores has been accomplished. The composition of Th^{4+}/HXO is 1:2 at pH 1.5-4.0. The apparent molar absorptivity is $\varepsilon = 5.6 \times 10^4$ 1 $mol^{-1}cm^{-1}$ at 550 nm. Beer's law is obeyed in the range of 0-20 µg/25 ml for thorium. (Paper received on 22 June 1983.)

AUTHOR: SHEN Hao [3088 3185]
         CHEN Defeng [7115 1795 5364]
         YE Lei [0673 5623]
         et al.

ORG: Department of Chemistry, Nanjing University

TITLE: "Application of Carbon Mat Electrodes to the Collection of Trace Metallic Ions"

TEXT OF ENGLISH ABSTRACT: A new method of electrochemical collection of trace metallic ions with the carbon mat electrodes (CME) is reported. A lot of trace metallic ions can be collected on the CME. The collecting efficiency of the CME for Cd^{2+}, Cr^{3+}, Cu^{2+}, Co^{2+}, Ag^+, Ni^{2+} and Zn^{2+} ($5 \times 10^{-8} - 10^{-6}$ g/ml) is approximately 98 percent in a single collection. The instrumentation is very simple and easy to use. (Paper received on 9 June 1983.)

AUTHOR: WANG Xianke [3769 3759 4430]

ORG: Lanzhou Steel Plant

TITLE: "The Color Reaction of Multicomponent Complex of Chromium (III) with 2-(5-Br-2-Pyridylazo)-5-Diethylaminophenol"

TEXT OF ENGLISH ABSTRACT: The complex of Chromium (III) with 5-Br-PADAP is studied in the presence of hydrogen peroxide and zephiramine, and is used for the determination of trace chromium. This method is characterized by high sensitivity and good selectivity, and has been successfully applied to the determination of trace chromium in water, industrial waste water, iron, steel and soil. (Paper received on 9 June 1983.)

AUTHOR: DENG Mingtao [6772 2494 1718]
          ZHANG Huaixi [1728 2037 3305]
          SHU Shilan [5289 0099 5695]

ORG: Chengdu University of Science and Technology

TITLE: "Automatic Monitoring of Trace Fluorides in Atmosphere with an
Ion-Selective Electrode"

TEXT OF ENGLISH ABSTRACT: An ion-selective electrode method for the determina-
tion of trace soluble fluorides in the atmosphere is investigated. A micro-
computer is used to control the analytical procedure. The air sample (20 to
30 1/min) and the absorbent (TISAB, 0.5 ml/min) pass through a coiled glass
tube in the same direction, ensuring complete absorption for the method is
completed satisfactorily. A single determination takes 6 minutes. The
determination limit is less than 1 $\mu g/m^3$ (calculated as F). (Paper received
on 14 July 1983.)

9717
CSO: 4009/1056

AUTHOR: YE Shuaiguan [0673 3764 1351]
           SHAN Shang [0810 1424]
           WANG Jie [3769 2638]

ORG: Department of Chemistry, Zhejiang University

TITLE: "Photometric Determination of Micro Silicon in Fine Vanadium Pentoxide with Multicomponent Complex of Silicovanadomolybdate Blue-Butyl Rhodamine B"

TEXT OF ENGLISH ABSTRACT: Fine vanadium pentoxide (V_2O_5 > 98 percent) contains micro amounts of silicon (about $10^{-2} - 10^{-3}$ percent). Because of the large quantity of vanadium in the determined system, a discussion of spectrophotometric method is made for the determination of micro quantities of silicon by the formation of silicovanadomolybdate blue-butyl rhodamine B complex in the aqueous phase. The maximum absorption wavelength of the complex is at 568 nm, and Beer's law is obeyed for 0-15 µg of SiO_2 in 100 ml. The value of the molar absorption coefficient is 1.4×10^5. The sensitivity of this method is raised obviously in contrast with that of the usual method of silicomolybdate blue. (Paper received on 10 October 1983.)

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AUTHOR: YANG Yuan [2799 0337]
           CHEN Yuanhui [7115 6678 1979]

ORG: YANG of the Epidemic Prevention Station, Qingbaijiang District,
Chengdu Municipality; CHEN of the Epidemic Prevention Station, Jintang County

TITLE: "Spectrophotometric Study of Magnesium-Chromazurol S-Surfactant
System"

TEXT OF ENGLISH ABSTRACT: In a buffer solution of KCl-NaOH at pH 12.5,
magnesium forms a blue complex with chromazurol S (CAS) and cetylpyridinium
bromide (CPB).   The maximum absorbance of the Mg-CAS=CPB is measured at
650 nm, and its molar absorptivity is $1.14 \times 10^5 \ 1 \cdot mol^{-1} \cdot cm^{-1}$.   The molar
ratio of magnesium to CAS is 1:4.   Beer's law is obeyed in the magnesium
concentration range of 0 to 10 μg/50 ml.   The method has been applied to the
microdetermination of magnesium in nodular cast iron with reliable results.
(Paper received on 17 October 1983.)

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     Horwood Ltd.,1976.
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AUTHOR: ZENG Xianjin [2582 2009 3160]
           MIAO Xiuzhen [4924 4423 3791]
           GUAN Shengli [7070 0524 0448]
           HUANG Benli [7806 2609 4539]

ORG: Changchun Institute of Applied Chemistry, Chinese Academy of Sciences

TITLE: "Determination of Major, Minor and Trace Elements in Coal Fly Ash by Inductively Coupled Plasma Atomic Emission Spectroscopy"

TEXT OF ENGLISH ABSTRACT: A method for simultaneous multielement analysis of coal fly ash with a multichannel ICP spectrometer has been developed. The sample was first digested with mixed nitric, hydrofluoric and perchloric acids in a Teflon-lined bomb at 180°C, and then the residue was filtered and fused with sodium hydroxide. Solutions containing pure matrix elements and the sample solution were used to investigate spectral interferences with the system's Polychromator Scan Software. For several trace elements interference correction was indispensable. Results for 17 elements (Al, Ca, Fe, K, Mg, Na, Ti, Ba, Be, Co, Cr, Cu, Mn, Ni, Sr, V and Zn) in the 82201 coal fly ash sample agreed well with those obtained with volumetric, colorimetric, AAS, ICF-AES, NAA and XRF techniques in other laboratories. (Paper received on 2 December 1983.)

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AUTHOR: REN Shangxue [0117 1424 1331]
          ZHANG Aimin [1728 1947 2404]

ORG: REN of Northwestern Institute of Soil and Water Conservation, Chinese
Academy of Sciences; ZHANG of the Prevention and Cure Institute of Endemic
Diseases, Luoyang

TITLE: "An Accurate Fluorescence Method for Determination of Selenium in
Drinking Water"

TEXT OF ENGLISH ABSTRACT: As soon as water samples are collected, they should
be acidized and stored in a plastic bottle sopped in 10 percent nitric acid
within 30 days for determination. A certain amount of Se^{6+} must be reduced
to Se^{4+} by hydrochloric acid in concentration over 4N. The rate of Se
recoveries is 90-106 percent, and the relative standard deviation is less
than 5 percent. (Paper received on 22 June 1983.)

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    lic Health Association, washington, 1979.
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AUTHOR: YU Suqing [0151 4790 3237]
          FU Xiaochun [0265 2556 2504]

ORG: Department of Chemistry, Nankai University

TITLE: "Spectrographic Determination of Rare Earth Impurities in Erbium
Oxide"

TEXT OF ENGLISH ABSTRACT: A simple and sensitive spectrographic method for
the determination of rare earth impurities in erbium oxide is proposed.
Carbon powder (S.P) is used as the buffer which is mixed with the sample
in the ratio of 1:1 by weight and a DC arc is used as the excitation source.
The sensitivities are: 1.5 ppm (europium), 5 ppm (yttrium), 6 ppm (thulium),
10 ppm (lanthanum holmium), 15 ppm (dysprosium, ytterbium), 20 ppm (lutetium),
30 ppm (cerium, neodymium), 50 ppm (samarium) and 60 ppm (praseodymium,
gadolinium, terbium). The standard deviations are 2.94 percent to 16.18 percent
respectively. (Paper received on 30 June 1983.)

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9717
CSO: 4009/1077

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TITLE: "Determination of the Depth Profile of Gold in Silicon Wafers by Masking, Etching Layers Removal-Neutron Activation Analysis"

TEXT OF ENGLISH ABSTRACT: This paper presents the techniques of masking and removing layers of silicon wafers coupled with neutron activation analysis, and the method for the determination of the depth profile of gold in silicon wafers. Reliable and convenient masking can be made by means of a homemade mold which has good corrosion resistance. The mold is particularly suitable for radioactive samples. The effects of the composition of the etchant, etching temperature and etching time on the etching rate are also investigated. By means of this method each thin layer removed can reach 5-20 μm in thickness. The total deviation of the removed layer thickness is about ±3 percent.

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TITLE: "The On-line Rapid Chemical Separation of Ge Isotopes from Heavy
Ion Reaction Products"

TEXT OF ENGLISH ABSTRACT: ^{66,67}Ge isotopes are produced by bombarding a
natural Ni target with ^{12}C ions at 72.5 MeV. The nuclear reaction products
are transported as far as 8 m with a He-jet system and separated in the gaseous
phase. The separating conditions of the Ge isotopes are studied in detail
with AgCl at 600°C as an additive and with He as the carrier gas at 1.2 atm.

The experimental results show that the Ge isotopes are separated satisfactorily
from the nuclear reaction products within 10 minutes and their adsorption
hields are above 60 percent. The decontamination factors of As and Ga are
$(8.21\pm3.53) \times 10^2$ and $(1.52\pm0.27) \times 10^2$ respectively.

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TEXT OF ENGLISH ABSTRACT: A combination of rapid chemical separation and a gas-jet transport system is used to investigate the decay properties of iodine obtained from $Ag(^{12}C, xn)I$ by bombarding natural Ag with a beam of ^{12}C at 67.4 MeV. The separation of I from Te and Sb is completed by solvent extraction within 25 to 40 seconds. The decontamination factors obtained are 60 for ^{113}Sb and 101 for ^{115}Te. However, the decontamination for ^{117}Te is only 17 because of decay from its precursor ^{117}I.

Sixteen γ-rays of I with rather high intensity are obtained, the partical decay properties of $^{117,118,119}I$ are investigated and the charge number of the product is assigned. Furthermore, seven γ-peaks that have not been obtained in the physical experiments are obtained distinctly, among which four γ-peaks (447.5 keV, 858.5 keV, 1303 keV and 1233 keV) have not been reported before. These four γ-peaks could well be the γ-rays of I, but further study in more detail needs to be done.

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TITLE: "Studies of the Extraction of Np(IV) with Bidentate Organophosphorus Extractant DHDECMP"

TEXT OF ENGLISH ABSTRACT: The extraction of Np(IV) and separation of Am(III) from Np(IV) by DHDECMP-DEB in a nitric acid medium is described.

Experimental results show that equilibrium for Np(IV) is reached in 30 s. The distribution ratio of Np(IV) decreases with an increase in temperature and increases with the concentration of nitric acid and DHDECMP. The enthalpy change $\Delta H_{NP(1v)}$ is estimated to be 15 kJ/mol. The logarithmic plot of $D_{NP(1v)} \sim$ [DHDECMP] is a straight line with a slope of 2.0. Therefore, the extraction reaction for Np(IV) with DHDECMP can be expressed as $Np^{4+} + 4NO_3^- + 2DHDECMP \rightleftarrows Np(NO_3)_4 \cdot 2DHDECMP$.

The separation of Am from Np can be achieved by means of nitric acid stripping with a separation factor of higher than 50.

9717
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TITLE: "On Computer The Multidimensional Fast Haar Transform"

TEXT OF ENGLISH ABSTRACT: An efficient fast algorithm based on a particular organization of data and matrix kronecker products is described for computing the multidimensional Haar transform. It not only maintains the advantages of the fast transform by reducing the numbers of storage elements and of arithmetic operations, but can provide a visual aid for the computational procedure. (Paper received on 6 Oct 82)

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TITLE: "A Practical Method For Solving Interaction Between The Upper
Structure And The Nonlinear Piles Of A Steel Offshore Platform"

TEXT OF ENGLISH ABSTRACT: This paper presents a practical method for the
calculation of the interaction between the upper structure of an offshore
platform and the nonlinear piles. The method enables simple and easy
calculations for the overall structure of the offshore platform, including
nonlinear piles. By using an equivalent composite beam set-up to choose
parameters and to simulate appropriately the action of pile bases bearing
nonlinear retroactive soil forces, the continuity and coordination of all
displacements and stresses on the top of the piles are guaranteed.
Calculation shows that this method requires only a few iterative calcu-
lations to achieve an error of 1 to 3 percent. Moreover, there is also
a clear advantage to the speed of calculation, owing to the use of sub-
structure technology and the simplicity and speed of single pile calcu-
lations. Furthermore, this method has taken into account the case of
the 3-dimensional action of piles, thus making the results even more
compatible with engineering practice. This method has been used with
the DASOS-S offshore platform program. (Paper received on 8 Nov 82)

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[4] Larry M. Bryant and Hudson Matlock, "Three-Dimensional Analysis of Framed Structures with nonlin-
    ear pile foundations" 1977 offshore Technology Conference, OTC 2955.

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TITLE: "On Estimating The Slopes Or The Tangential Vectors In Curve Fitting"

TEXT OF ENGLISH ABSTRACT: First the approximating accuracy of the inter-polating function based on Akima's method of estimating the slopes at data points in single-valued cases is discussed. A method of estimating the tangential vectors at data points is then presented. Its major advantages are: the computation is simple and the amount of operations is small and the curve generated by using the parametric cubic interpolation based on this technique is good. It can be applied to computer curve out-put, especially to such applications as tracing and drawing contour maps. (Paper received on 30 Oct 82)

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TITLE: "Application Of Power Transformation To Programming Source Programs"

SOURCE: Beijing SHUZHI JISUAN YU JISUANJI YINGYONG [JOURNAL ON NUMERICAL METHODS AND COMPUTER APPLICATIONS] in Chinese Vol 6, No 2, Jun 85 pp 72-81

TEXT OF ENGLISH ABSTRACT: The power transformation is introduced into data processing by source program in order to directly expand the range of the computer adaptability for real numbers, so that the computer capacity is enhanced. (Paper received on 15 Sep 82)

12949
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of Science, Beijing

TITLE: "Anisotropic Superconducting Critical Currents for in Situ Composites
Cu-Nb"

TEXT OF ENGLISH ABSTRACT:

Highly oriented Cu-Nb in situ composites have been studied to determine the chan-
ges in superconducting critical current which occur as the relative orientation of the
magnetic field, transport current and filament direction are changed. Samples having
Cu barrier thickness in the range from 5 to 500 nm show J_c values about a factor of 40
higher for the current parallel to the long axis of the filaments than for the current
perpendicular to the long axis. Where the flux line lattice moves perpendicular to
the filament direction, the data show that the shear modulus, C_{66}, governs the flux pin-
ning. Where the flux line lattice moves parallel to the long axis of the filaments the
fall in critical current with field is much more rapid.

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     (1977), 853.

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TITLE: "The Current-Phase Relation of the Superconductive Tunnel Junction in Nonstationary Process"

TEXT OF ENGLISH ABSTRACT:

The current-phase relation of the superconductive tunnel junction can be derived from the TDGL equations with definite boundary conditions by using a perturbation treatment. The nonstationary process has been investigated. The total amount of current through the junction can be calculated by giving a fixed voltage at the sides. Moreover, when a given current goes through the tunnel junction, an equation which satisfies the phase difference can be obtained. It is noticeable that this equation is different from that as suggested by the RSJ model.

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12949
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TITLE: "Magnetic Properties and Spin Wave Excitation at Low Temperature for Amorphous (Fe$_{1-x}$Nb$_x$)$_{84.5}$B$_{15.5}$Alloys"

TEXT OF ENGLISH ABSTRACT:

The ribbons of amorphous $(Fe_{1-x}Nb_x)_{84.5}B_{15.5}(0 \leqslant x \leqslant 0.1)$ alloys are produced by melt quenching using a rotating drum apparatus. The magnetization is measured with an extracting sample magnetometer between 1.5 and 90K in fields up to 70 kOe, and with a magnetic balance between 77 and 300 K in fields 12 kOe. It shows that the spontaneous magnetization decreases almost linearly with the increasing Nb content. The calculated average magnetic moment is 2.05 μ_b for per Fe atom and $-2.57 \mu_b$ for per Nb atom. The spin wave stiffness constant D decreases from 71.3 MeV $Å^2$ ($x=0$) to 59.8 MeV $Å^2$ ($x=0.1$), which is calculated from the relation $\sigma(T)/\sigma(0) = 1 - BT^{3/2} - CT^{5/2}$ but D/T_c almost independent with Nb content. The mean-square range of the exchange interaction $\langle r^2 \rangle$ is between 11.8$Å^2$ and 13.6 $Å^2$ for $x=0$ and 0.1.

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TITLE: "Preparation of Thin V Films and Their Superconducting Transition Temperatures"

TEXT OF ENGLISH ABSTRACT:

   Thin V films are deposited on the crystallite-glass and the fused quartz substrates at the temperature greater than 150°C under the vacuum of 1×10^{-5} torr in the general vacuum system with an electron gun source. The analyses of Auger electron spectra show that V films contain a greater amount of oxygen and carbon and that the oxygen peak in the interior of the V film is much lower than that at the surface. The superconducting transition temperatures of V films, T_c, have been measured and the maximum T_c is 4.35 K. The transition temperatures of V films are proportional to the ratio of the resistances, $(\rho_{300}-\rho_r)/\rho_{300}$. In this paper we emphasize that there are two important factors for preparing V films with T_c greater than 4K even if the vacuum is as poor as 1×10^{-5} torr during the deposition. One is keeping the substrate temperature at higher temperature. The other is that before the deposition the pre-evaporation should be done for several times to reduce the partial pressure of the residual gas O_2 in the vacuum chamber.

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TITLE: "Protection of Superconducting Magnets with the Secondary-Short-Circuit"

TEXT OF ENGLISH ABSTRACT:

Studies have been made on the difficulties in large superconducting magnet protection against its melt and high voltage, and the principle of protection with a secondary short-circuit. A Nb-Ti superconducting magnet with a secondary short-circuit made of high purity aluminium wire has been used for test. The experimental observations show that when the power supply is switched off, and when the magnet is still in superconducting state, the stored energy of the magnet is essentially transferred into the secondary winding. When the magnet was quenched by heating a part of the magnet current is transferred into the secondary-short-circuit. The greater the initial current of magnet, the greater is the transfer rate. We have also observed that the secondary winding apparently decreases the end voltage of magnet when the power supply is cut off.

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12949
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TITLE: "The Influences of Nonequilibrium Quasiparticle Recombination Time on the Inhomogeneous Threshold of Superconducting Thin Film"

TEXT OF ENGLISH ABSTRACT:

According to Scalapino-Huberman equation, it is suggested that the influence of nonequilibrium quasiparticle number on the quasipaiticle recombination time should bring about changes in the long wave parts of the S-H results and that the time period solutions should be obtained.

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12949
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TITLE: "Frequency Dependence of the Freezing Temperature in CoGa Spin Glasses"

TEXT OF ENGLISH ABSTRACT:

Temperature dependence of low-field-ac-susceptibility (temperature range: 1.8—40K, frequency range: 15—1000 or 5000Hz) and that of low-field-dc-magnetization on Co_xGa_{1-x} slow-cooled spin glasses $(0.52 \leqslant x \leqslant 0.56)$ are shown in this paper. The experimental results obey the Fulcher law: $\tau = \tau_0 \exp[E_a/k(T_f - T_{f_0})]$. A phenomenological interpretation has been made, suggesting that the freezing of the local magnetic moments in spin cluster glasses at T_{f_0} is the phase transition and this freezing in the temperature range of $T \gtrsim T_{f_0}$ exhibits relaxation behavior.

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TITLE: "Thermoelectric Power PTS Single Crystal at Low Temperatures"

TEXT OF ENGLISH ABSTRACT: The thermoelectric power of PTS has been measured in terms of differential method in the range from 77 to 273 K. The results show the thermoelectric power of PTS increases linearly with temperature. There is a jump in the thermoelectric power near 114 K. At about 150 K and 220 K the thermoelectric power decreases rapidly and two drop-peaks of the power curve occur respectively.

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12949
CSO: 4009/1090

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TITLE: "A Simple Apparatus for Measuring Susceptibility of Superconducting Materials"

TEXT OF ENGLISH ABSTRACT:

A simple apparatus to obtain direct and continuous recordings of the variation of the imaginary χ'' and the real part χ' of the susceptibility of superconducting materials is reported in this paper. This apparatus is inexpensive. In addition its construction presents no difficulty and it is quickly operational. The whole performance of the measuring system was examined by using Pb direct reading of χ' and χ'' are given.

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12949
CSO: 4009/1090

Cryogenics

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TITLE: "The Application of Microcomputers to the Measuring Technology of Platinum Resistance"

TEXT OF ENGLISH ABSTRACT:

The platinum resistance thermometer is a standard interpolating instrument of the international practical temperature scale of 1968 (IPTS-68). But the formula for resistance-temperature stipulated by IPTS-68 is very complex and has given rise to problems in calculation and measurement of low temperature. This paper, from the viewpoint of software, gives an account of how to solve the above-mentioned problems by using the technology of microcomputers and illustrates with examples the possibility to solve them.

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12949
CSO: 4009/1090

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TITLE: "Experimental Investigation of the 7.22 T NbTi Pulse Superconducting Magnet"

TEXT OF ENGLISH ABSTRACT:

This paper describes the experimental results of a superconducting coil with a d.c. central field 7.22 T, maximum field 7.94 T and pulse operating peak field 6.99 T. The peak field is 96.6 per cent as large as d.c. critical field.

12949
CSO: 4009/1090

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TITLE: "Effect of In, Ga, on the Diffusion Process and Superconducting Properties of Nb$_3$Sn Composites Formed from High-Tin Content Cu-Sn Alloys"

TEXT OF ENGLISH ABSTRACT:

This paper presents the preliminary experimental results of the effect of In, Ga additives on the diffusion process and superconducting critical properties of Nb$_3$Sn multifilamentary composites formed from high-tin-content Cu-Sn alloy.

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TITLE: "Research of the CMOS Circuits for Optimal Universal-Logic-Gate"

SOURCE: Hangzhou HANGZHOU DAXUE XUEBAO (ZIRAN KEXUE BAN) [JOURNAL OF HAN-
ZHOU UNIVERSITY (NATURAL SCIENCES EDITION)] in Chinese Vol 11, No 3 Jul 84
pp 316-324

TEXT OF ENGLISH ABSTRACT: Two CMOS practical circuits for the optimal Universal-
Logic-Gate (ULG.2) are presented. Through theoretical analysis, experiments and
comparison with traditional CMOS gates, it is considered that either of the two
practical circuits for ULG.2 may be adopted as a standard cell for LSI uncommitted
logic arrays.

12949
CSO: 4009/1028

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TITLE: "The V-P Structure Model for Ion Plated Aluminum"

TEXT OF ENGLISH ABSTRACT: The effects of different argon pressures and
substrate biases on the Al-film structure have been systematically studied
with a 240° e-type electron beam gun used as the source of the vapor.
A model, named the Al-Film V-P Structure Model by Ion Plating (V-P Model),
is established with two variables, argon pressure and substrate bias. It is
shown from the model that at the different argon pressures needed to eliminate
conical and columnar grains, different substrate biases are needed. If the
argon pressure is higher than 5 x 10^{-3} torr, the bias needed to eliminate the
above grains decreases with the increase of argon pressure. If the pressure
is lower than 5 x 10^{-3} torr, this bias decreases with the decrease of the
pressure. This bias value reaches its maximum at 5 x 10^{-3} torr.

It is suggested that this three-dimensional V-P structure model is a result
of the combination of the effects of different pressures and biases on Al-film
structure during deposition.

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     Tokyo, (1973) 231.
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         SUN Yunlong [1327 0061 7893]

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TITLE: "Nitrogen Spectrum Leak Detector"

TEXT OF ENGLISH ABSTRACT: Some experimental results of the nitrogen spectrum
leak detector are described. The spectra excited in a Penning ionization
gauge can be used for quick monitoring of the pressure in a vacuum system and
for leak detection.

Discharge spectra for various gases at a pressure of about 10^{-4} Torr were
obtained and compared. Three strong spectral lines in the visible region
have been found for nitrogen. Computational results indicate that these lines
are due to the transitions from $\nu' = 0$ of the electronic excited state to
$\nu'' = 0$, 1 and 2 of the electronic ground state for N_2^+ respectively.

The 4278 $\overset{\circ}{A}$ nitrogen ion spectral line was chosen as a working reference for
leak detection. In a vacuum system consisting of an oil diffusion pump and a
mechanical pump, the ratios between the photocurrent at 4278 $\overset{\circ}{A}$ to the total
photocurrent were obtained under different conditions.

Using oxygen as the probing gas, under the present experimental conditions
the lowest detectable leakage rate is less than 3×10^{-7} Torr·liter/sec with
a response of several seconds.

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TEXT OF ENGLISH ABSTRACT: A molecular beam glass apparatus for investigating gas-surface interactions is described. It was designed and manufactured in light of specific conditions at our laboratory. Its advantages are low cost and ease in manufacturing. In this apparatus a molecular beam study of catalytic oxidation of CO on Pt (polycrystalline) has been performed. Experimental results reveal that this apparatus can characterize different processes of gas-surface reactions (heterocatalysis).

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ZOU of the Measuring Technique Research Institute, Shanghai Metrology Bureau

TITLE: "A Line Shape Analysis of $SiL_{2,3}VV$ Auger Spectrum on the Cleaved (111)
Surface"

TEXT OF ENGLISH ABSTRACT: The $SiL_{2,3}VV$ Auger spectrum on a cleaved (111)
surface was measured. The local transition density of state on this surface
has been obtained by digital integration, back subtraction and self-
deconvolution techniques. The results agree well with the optical density
of state measured by UPS on the Si (111) 2 x 1 surface.

113

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LI and ZHAN of North China Research Institute No 3, Tianjin

TEXT OF ENGLISH ABSTRACT: The base metals of oxide-coated cathodes, an alloy
of Ni-W-Mg and the Ni-Mg alloy containing a high concentration of Mg which
have not been heat treated, were cleaved by low energy argon ions (2 keV) and
analyzed by an Auger electron spectrometer (PHI 550). It can be seen from
the Auger electron spectra of the elements that there were enrichment layers
of Mg on the surfaces of the specimens.

The experiments relative to the reasons for forming Mg enrichment have been
carried out and the related reasons are discussed.

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9717
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TITLE: "Effect of Micromixing upon Selectivity of a Homogeneous Instantaneous Complex Reaction. (I) Dual-sphere Model"

TEXT OF ENGLISH ABSTRACT: An instantaneous homogeneous complex reaction is essentially an unsteady-state diffusion-reaction process, in which product distribution depends upon the degree of micromixing of the reactants. A dual-sphere model is developed here. By taking a competitive second-order reaction system as an example and using an appropriate computational method, the influences of different parameters on the reaction results have been simulated and discussed. (Received on 14 March 1983 and finalized on 28 May 1984.)

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TEXT OF ENGLISH ABSTRACT: The ultrasonic degradation and copolymerization
of polyvinyl acetate (PVAc) with partially hydrolyzed polyacrylamide (HPAM)
in ethanol/water (55/45) have been studied. The experimental results show
that the rate of degradation of PVAc follows Ovenall's equation approximately
and that of HPAM deviates from the equation. The effects of the ultrasonic
intensity and reaction temperature on the rates of degradation are the same.
By irradiating 0.50 percent PVAc/HPAM (1/1 by weight) at 25°C with ultrasound
of 18.2 kHz and 2.4 A input current on a reversed main circuit for 10 minutes,
the copolymer yield was 4.3 percent. Its structure was identified by means
of a solubility test, IR, NMR, element analysis, electron microscope and phase
contrast microscope, and the copolymer was proved to be mainly a block one.
(Received on 27 January 1983, and finalized on 2 April 1984.)

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           et al.

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TITLE: "Kinetic Study of Carbon Gasification on Nickel Catalysts with Steam-Hydrogen Mixture"

TEXT OF ENGLISH ABSTRACT: The kinetic features of the gasification with a H_2O-H_2 mixture of carbon deposited on the nickel catalysts for steam reforming of naphth are reported in the temperature range of 723-973K. Investigations were mainly carried out in a TG-monitored flow reactor system. Two kinds of industrial nickel catalysts, the domestic Z402 and the British ICI46-1, were selected for study.

Empirical rate equations of carbon gasification with H_2O-H_2 mixture were obtained for the lower and higher temperature ranges respectively. Empirical rate equations of carbon gasification with steam alone were also given for comparison.

A TG-scan of the carbon gasification process revealed that steam alone does have an oxidizing effect on the nickel catalyst and that, with a H_2O-H_2 mixture of a suitable H_2O/H_2 ratio, this effect can be eliminated. This will prevent the catalyst from deteriorating due to repeated oxidation and reduction.

It was shown that H_2 in the H_2O-H_2 mixture has two opposite functions. It has an inhibiting effect through its negative reaction order, but can also have an accelerating effect by keeping the Ni catalyst from being oxidized by steam. This is significant for the lower temperature region where the rate of carbon gasification is usually low. (Received on 26 February 1983, and finalized on 17 September 1983.)

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TITLE: "A Model for Predicting Fouling Behavior of Cooling Water"

TEXT OF ENGLISH ABSTRACT: Extensive experimentation on a simulated fouling testing facility showed that cooling water initially fouled quite rapidly, but ultimately the rate of fouling diminished to some constant, asymptotic values. Frequently it was observed that an induction period existed before the formation of any deposit, and an implicit solution of the Kern-Seaton equation could therefore not be obtained satisfactorily by trial-and-error.

Based on a large set of data, a new model was postulated to show the above mechanism of fouling:

$$R_f = R_f^* \exp(-A/(t-t_0))$$

This exponential model involves an induction period, and linearized regression could be used to solve for the parameters R_f and A.

Results of regression analysis of 60 runs with a TI-59 programmable calculator indicate that most correlation coefficients for the new model are greater than 0.9. With this new equation, the asymptotic fouling resistance can be estimated directly from experimental data. (Received on 22 March 1983, and finalized on 10 December 1983.)

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9717
CSO: 4009/1072

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TITLE: "Double Grating Frequency Shift Effect of Laser Beam and Its
Application"

TEXT OF ENGLISH ABSTRACT: Frequency shifts of the double grating is considered
and confirmed by our experiment. Using this effect we determine the value of
velocity or small displacement. It is simpler than the method of Michelson's
instrument or the intensity modulating method and has been successfully
tested on Mossbauer spectrometer to determine the velocity of vibration.
Satisfactory results have been obtained.

12949
CSO: 4009/265

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TITLE: "Investigation on the Barium Sodium Niobate Acoustic-optic Modulator/Frequency Doubler for Nd: YAG Lasers"

TEXT OF ENGLISH ABSTRACT: We have achieved the acoustic-optic modulation and the second harmonic generation for Nd: YAG lasers simultaneously in the same barium sodium niobate crystal. In this paper, the structure and fabrication of this complex functional device are described. Its central frequency is 129 MHz and total diffraction efficiency is higher than 50 percent (6328 A) at a driving voltage of 3 volts.

12949
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SHAO and YUE of the Shanghai Institute of Laser Technology

TITLE: "Photophysical Parameters and Lasing Characteristics of DCM--Propylene
Carbonate System"

TEXT OF ENGLISH ABSTRACT: Based on our study of photophysics of DCM in
different solvents, it has been suggested that propylene carbonate can be used
as a more attractive solvent for DCM lasing medium. This prediction has been
demonstrated by the experimental results reported in this paper.

12949
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ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Experimental Research on the Multichannel Rail Gap for Transverse Discharge Gas Lasers"

TEXT OF ENGLISH ABSTRACT: The multichannel rail gap for transverse discharge gas laser has been developed. The effects of trigger voltage and trigger electrode configuration on the characteristics of the rail gap were studied, and 29 channels per meter in a rail gap of 38cm long was obtained.

12949
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ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Design and Analysis of Resonators for the CW Dye Laser Pumped by an Ar+ Laser"

TEXT OF ENGLISH ABSTRACT: The design of the folded three-mirror cavity and four-mirror ring cavity is described. The effects of the cavity adjustment on the properties of laser resonators have been emphasized. The analyses are important for the correct design and alignment of the cavity.

12949
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ORG: Zhejiang Provincial Weather Bureau

TITLE: "The Nested and Relaying Grid Model Used for Typhoon Track Numerical
          Forecasting"

TEXT OF ENGLISH ABSTRACT: Based on large-scale numerical forecast, the model can
provide more accurate forecasting with smaller computers. The primitive equations
in this model are divided into two parts: advective process and adjustment process.
The split explicit integrating scheme is used in time integration. The spline func-
tion is employed in space finite difference. There are two kinds of horizontal grid
spacing: coarse mesh and fine mesh, the fine mesh can be moved with typhoon. Initial
field comes from large scale forecastion provided by national or regional meteoro-
logycenter. The results show that this model is efficient, more accurate, and more
economical. It is suitable for the use in operational forecasting.

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TITLE: "An Interpolating Spline Curve With Keeping Convexity"

TEXT OF ENGLISH ABSTRACT: A type of cubic interpolating spline curves is constructed through joining each two successive points on the plane with three pieces of cubic uniform B-Spline curves. Its keeping convexity is similar to that of the cubic B-Spline curve when parameter λ is properly selected. Moreover, it has continuous derivative of second order and explicit form. (Paper received on 15 Sep 82)

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AUTHOR: XU Chengxian [1776 2052 6343]

ORG: Xian Jiaotong University

TITLE: "A New Direct Search Algorithm With Decreasing Dimensions"

TEXT OF ENGLISH ABSTRACT: A new direct search algorithm with successively decreasing dimensions of search spaces is presented to determine the optimal point of f on R^n, and its quadratic convergence is proved. The line search times needed in direct search algorithms are proved to be $1/2n(n+1)$'s. (Paper received on 6 Oct 82)

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12949
CSO: 4009/1084

AUTHOR: CHU Cheng [5969 2052]
          HU Yu [5170 3558]

ORG: Shanghai Institute of Optics and Fine Mechanics, Academia Sinica

TITLE: "Design of a Diode of FEL"

TEXT OF ENGLISH ABSTRACT: The design method of a low emittance diode, the key
component of a Raman-scattering FEL is presented. The space-charge-limited
diode is immersed in a strong guiding magnetic field; the profile of its
cathode can be evaluated numerically from the required e-beam parameters and
anode profile.

12949
CSO: 4009/265

AUTHOR: LIU Rongguang [0491 2837 0342]
          WU Jianwu [0702 1017 2976]
          XIE Peipei [6200 0160 0160]
          DONG Xueseng [5516 7185 3932]

ORG: Institute of High Energy Physics, Chinese Academy of Sciences

TITLE: "The Performance Test of 1m x 1m Drift Chambers with On-line Microcomputer"

TEXT OF ENGLISH ABSTRACT: The performance of a 1m x 1m drift chamber system has been measured with an on-line microcomputer using cosmic rays. The time resolution is 4.26 ns, the spatial resolution is 132 μm and the efficiency is above 96 percent. The experimental set-up includes five 1m x 1m adjustable field drift chambers, a scintillation counter trigger system, read-out electronics and a TRS-80 microcomputer. The data acquisition and processing have been performed with an on-line microcomputer and off-line data analysis.

AUTHOR: MA Jimao [7456 1015 5399]
WANG Yunyong [3769 6663 3057]
MAO Zepu [3029 3419 2528]
et al.

ORG: Institute of High Energy Physics, Chinese Academy of Sciences

TITLE: "Preliminary Test for Aging Effect of Drift Chambers"

TEXT OF ENGLISH ABSTRACT: The degradation of some performances of the drift chambers irradiated with a 5 MeV electron beam has been tested. The gas mixtures filled were Ar/CO_2, Ar/CH_4 and Ar/iC_4H_{10} in proportion.

The dark current, pulse height, energy resolution and counting rate plateau were measured during the irradiation.

AUTHOR: LIU Yuan [0491 3220]
          LI Yangguo [2621 2254 0948]

ORG: Institute of High Energy Physics, Chinese Academy of Sciences

TITLE: "Nucleus-Nucleus Inelastic Scattering and the Influence of Projectile Nuclei Structure at High Energies"

TEXT OF ENGLISH ABSTRACT: Based on Glauber's theory, nuclei-nuclei inelastic scattering amplitudes are given using the rigid projectile approximation. Inelastic scattering differential cross sections of $\alpha+C^{12}$ at 1.37 GeV with 2^+(4.43 MeV) and 3^-(9.64 MeV) of C^{12} in the final state are calculated. The influence of the different density distributions of the projectile nuclei on nuclei-nuclei inelastic scattering is discussed.

AUTHOR: LI Yangguo [2621 2254 0948]
          MA Weixing [7456 4850 5281]

ORG: Institute of High Energy Physics, Chinese Academy of Sciences

TITLE: "S-Wave πN Interaction in (π^+, d) Reaction"

TEXT OF ENGLISH ABSTRACT: Based on the two nucleon pion absorption mechanism, the reaction (π^+, d) is studied. The formula for the differential cross section of the (π^+, d) reaction is obtained for S-wave πN interaction. A calculation is also performed for ^{12}C(π^+, d) ^{10}C(0^+, 2^+) at the incident energy of 49.3 MeV by using the plane wave approximation. The results indicate that the effect of the D-wave component in the deutron wave function is quite important. The antisymmetric space structure of the neutron pair participating in the process is as important as the symmetric one.

AUTHOR: REN Wenbin [0117 2429 1755]
          LI Guanglin [2621 1639 2651]
          YAN Binshan [7346 2430 1472]

ORG: Institute of High Energy Physics, Chinese Academy of Sciences

TITLE: "Energy Doubler"

TEXT OF ENGLISH ABSTRACT: The energy doubler (ED) multiplication factor and the energy spectrum caused by the instantaneous beam loading compensated for by the inherent energy spectrum of ED in the electron Linac are derived under the linear variation condition for the top of the klystron output pulse.

AUTHOR: LIU Shaoxiang [0491 4801 3276]

ORG: Lanzhou University

TITLE: "Single Proton Transfer Reaction Induced by Heavy Ion ^{40}Ar (^{11}B, ^{10}Be) ^{41}K"

TEXT OF ENGLISH ABSTRACT: The angular distribution has been measured for elastic scattering on ^{40}Ar with ^{11}B and for the single proton transfer reaction ^{40}Ar(^{11}B, ^{10}Be)^{41}K at the incident beam energy of 50 MeV. The elastic scattering cross section has been fitted in terms of the optical model. The EFR-DWBA approach with recoil effect has been used to analyze the differential cross section. The spectroscopic factor was extracted.

AUTHOR: SHEN Wenqing [3088 2429 1987]
          YIN Shuzhi [1438 3219 5695]
          GUO Zhongyan [6753 1813 6056]
          JIANG Chenglie [1203 2110 3525]
          et al.

ORG: SHEN, YIN, GUO, et al., of the Institute of Modern Physics, Chinese
Academy of Sciences, Lanzhou; JIANG of the Institute of Atomic Energy,
Chinese Academy of Sciences, Beijing

TITLE: "Measurement of Projectile-like Fragments Produced by 80.6 MeV
^{16}O on ^{27}Al"

TEXT OF ENGLISH ABSTRACT: The projectile-like fragments produced by 80.6 MeV
^{16}O on ^{27}Al were measured using the large area position sensitive ionization
chamber. The energy spectra, angular distributions, contour plots of
$d^2\sigma/d\Omega$ E in the E-θ plane of the reaction products from Li to Na and the
Z-distribution were obtained. The cross sections of the quasi and deep
inelastic scattering were introduced. A brief discussion of the experimental
results is also given.

9717
CSO: 4009/268

AUTHOR: HU Gang [5170 1511]

ORG: Department of Physics, Beijing Normal University

TITLE: "Time Dependent Solution of Fokker-Planck Equation with Non-linear Drift Force"

TEXT OF ENGLISH ABSTRACT: A new approach to the Ω-expansion of Green's function is employed to study the time dependent problem of the Fokker-Planck equation. The scaling region and final region in the scaling theory are unified to a single region. As $t \to \infty$, the time dependent solution approaches the stationary solution of the Fokker-Planck equation. The difficulty in matching the last two time regions in the scaling theory is then avoided.

AUTHOR: WANG Pengye [3769 7720 2814]
          DAI Jianhua [2071 1696 5478]
          ZHANG Hongjun [1728 3163 6874]

ORG: Institute of Physics, Chinese Academy of Sciences

TITLE: "Bifurcation, Chaos and Transient Behavior in Liquid Crystal Hybrid Optical Bistable Devices"

TEXT OF ENGLISH ABSTRACT: Bifurcation and chaotic behavior in liquid crystal hybrid optical bistable devices are calculated and analyzed based on the relaxation equation with time-delayed feedback. We also find that there is a transient oscillation with period t_R within the bistable region.

AUTHOR: HU Shuqin [5170 3219 3830]
          LIAN Zhongxiang [6647 6988 4382]

ORG: Institute of Physics, Chinese Academy of Sciences

TITLE: "An Experiment of 90° Thomson Scattering on CT-6B Tokamak Device by Using a Ruby Laser as Light Source"

TEXT OF ENGLISH ABSTRACT: In this paper we describe briefly the 90° Thomson scattering system of Tokamak CT-6B, using a ruby laser as the light source. The measurements of the 90° Thomson scattering spectra, electron temperature T_e and density n_e are discussed, and the results are given. The results of electron density measurement agree with those obtained by 2 mm microwave interferometer diagnosis.

AUTHOR: SU Fang [5685 2499]
          YU Weizhong [6735 0251 0022]
          DAI Daoyang [2071 6670 2254]
          ZHAO Zongyuan [5392 1350 3293]

ORG: SU of the Fundamental Physics Center, University of Science and
Technology of China, Hefei; YU of the Department of Physics, Qinghua University;
DAI and ZHAO of the Institute of Physics, Chinese Academy of Sciences

TITLE: "Positron Lifetime Spectra and Scanning Electron Microscope Investigations During the Crystallization Process of Amorphous Ionic Conductor B_2O_3-$0.7Li_2O$-$0.7LiCl$-xAl_2O_3"

TEXT OF ENGLISH ABSTRACT: The traditional pressed powder samples seriously
spoil the accuracy and reproducibility in measuring positron lifetime spectra
and scanning electron microscopy. This paper describes overcoming the above
difficulties by preparing large amorphous disk samples and obtaining new
results of positron lifetime spectra and scanning electron microscopy during
the crystallization process.

According to our experiments on the amorphous ionic conductor B_2O_3-$0.7Li_2O$-
$0.7LiCl$-xAl_2O_3, we find that the mean lifetime of a positron at room temperature
is not affected by content variation of Al_2O_3, with the mean lifetime of the
positron decreasing greatly after full crystallization. Moreover, during the
beginning of the crystallization process, the mean lifetime of the positron
of the sample $x = 0.15$ exhibits a notable anomalous enhancement which occurs
within the same temperature range as does the anomalous enhancement of ionic
conductivity.

AUTHOR: TONG Litai [4547 5461 3141]
          ZHOU Zengjun [0719 1073 0971]
          WANG Guizhi [3769 2710 0037]

ORG: Department of Physics, Beijing University

TITLE: "Low Temperature Thermoelectric Power of Amorphous $(Fe_{1-x}Cr_x)_{84}B_{16}$ Alloys"

TEXT OF ENGLISH ABSTRACT: The absolute thermoelectric power S of amorphous metallic alloys $(Fe_{1-x}Cr_x)_{84}B_{16}$ has been measured as a function of temperature in the range of 80 to 380 K for $0.01 \leq x \leq 0.46$. It is found that the behavior of S(T) for the magnetic alloys does not always follow a nonlinear variation law with a shallow minimum. The addition of a small amount of Cr $(x \leq 0.05)$ is shown to lower the absolute value of S and wash out the minimum. With a larger Cr content, the alloys are weakly magnetic and the behavior of S(T) changes from nonlinear, typical of magnetic amorphous alloys, to nearly linear, similar to that of nonmagnetic alloys. A value of x of 0.15 and 0.25 is not found to have any effect on the value of S at the Curie temperature T_c, which happened to be in our working temperature region.

139

AUTHOR: DING Xunmin [0002 6064 3046]
          DONG Guosheng [5516 0948 0524]
          YANG Shu [2799 2562]
          et al.

ORG: Modern Physics Institute, Fudan University, Shanghai

TITLE: "An Electron Spectroscopy Study of the In/GaAs (111) Interface Formation Process"

TEXT OF ENGLISH ABSTRACT: The interface formation process for In deposited on noncleaved GaAs (111) plane has been studied by means of photoemission spectroscopy combined with LEED pattern analysis. It is shown that the growth of three-dimensional In clusters dominates in this process. The surface Fermi level is found at 0.75 ± 0.05 eV above VBM for all the investigated n-type samples prior to the deposition of In: these include both Ga-terminated GaAs (111)-A and As-terminated GaAs (111)-B faces. The Fermi level rapidly shifts to 0.90 ± 0.05 eV above VBM during the deposition of In.

AUTHOR: ZHANG Yuheng [1728 5940 1854]
          LIU Hongbao [0491 1347 1405]
          YUAN Songliu [5913 2646 2692]
          CAO Xiaowen [2580 2400 2429]

ORG: ZHANG, LIU and YUAN of the Department of Physics, University of
Science and Technology of China, Hefei; CAO of the Institute of Plasma
Physics, Chinese Academy of Sciences, Hefei

TEXT OF ENGLISH ABSTRACT: The relationship between conductivity $\sigma(T_a)$ and
temperature T has been investigated experimentally for samples with different
structures under phase transition. We have found anomalous phenomena on
superconducting transition R(T) curves corresponding to some special phase
transition zones as the samples crystallize into a metastable intermediate
phase.

In this paper, a mixed state model is suggested in which the metastable
metal-phase and the quasi-semiconducting phases are mixed. Based on this
model, the anomalous phenomenon can be explained and the theoretical calcula-
tions carried out. The theory is in agreement with experimental data.

AUTHOR: CAO Zhongsheng [2580 1813 0524]
         ZHAO Zhongxian [6392 1813 6343]
         FENG Benzheng [7458 2609 2398]

ORG: CAO and ZHAO of the Institute of Physics, Chinese Academy of Sciences;
FENG of the Institute of Noble Metals, Kunming

TITLE: "Resistivity of Metallic Glass CuTi"

TEXT OF ENGLISH ABSTRACT: We choose the typical metallic glass $Cu_{1-x}Ti_x$
alloys with two concentrations (x = 0.300 and x = 0.325) made by a melt-
spinning technique for the sample. The X-ray diffraction, DTA and DSC
analyses show that the samples exhibit typical amorphous characteristics.
In the wide temperature of 2-700 K, the resistivity is in accordance with
the Mooij rule. Based on the Nagel nearly free electron model, Mott s-d
scattering model, quasi-particles excitation by disorder configuration model
and two-level tunnelling model for the electrical transport properties of
amorphous alloys, the results are analyzed. The theoretical results of the
two-level tunnelling model agree the best with the experimental data.

9717
CSO: 4009/273

AUTHOR: CHEN Guicong [7115 2710 0654]
SHAN Qizhe [0830 0796 5832]

ORG: Department of Physics, Shandong College of Oceanography

TITLE: "Use of Multiple Exposure Synthetic Slit in Rainbow Holography of
Diffuse 3-D Objects"

TEXT OF ENGLISH ABSTRACT: Extending the synthetic slit method in rainbow
holography of diffuse 3-D objects [1,2], a quasi-monochromatic reconstructed
image is obtained by means of multiple exposure under white light
illumination. A theory of multiple exposure synthetic slit is described and
the effects of exposure times and object displacement for synthetic slit are
discussed. Experimental results are also included.

12949
CSO: 4009/265

AUTHOR: ZHUANG Jiejia [1413 2638 0163]
        ZHAO Runqiao [6392 3387 0829]
        YE Guimu [0673 2710 2606]
        et al.

ORG: ZHUANG of the Institute of High Energy Physics, Academia Sinica; ZHAO
and YE of the Institute of Electronics, Academia Sinica

TITLE: "Theoretical Analysis and Experimental Demonstration of the Radially
Polarized Laser Field"

TEXT OF ENGLISH ABSTRACT: The phase-adjusted focusing laser accelerator
requires a laser field with special polarized distribution---a radial
polarization. The theoretical work shows, by properly transforming the TEM00
mode, such a laser field can be obtained and propagate stably in the free
space. The experimental result agrees with the theoretical analysis.

12949
CSO: 4009/284

AUTHOR: YAN Shousheng [7051 1343 0524]
         GAO Liming [7559 0448 2494]
         WAN Junzuo [8001 0689 0146]
         et al.

ORG: Department of Physics, Beijing University

TITLE: "Anomalous Behavior of the Low Temperature Phonon Conductivity of an
FeMnAl Alloy"

TEXT OF ENGLISH ABSTRACT: Measurements have been made at 4.2--30 K for the
thermal conductivity of a polycrystalline Fe-25Mn-5Al-0.2C sample with
negative temperature coefficient of resistivity.   It is found that the phonon
conductivity is anomalously proportional to T. The suggested explanation is
that this phenomenon results from the noneffectiveness of the scattering of
phonons by electrons, when electrons have short mean free path caused by
the addition of Al.

12949
CSO: 4009/284

AUTHOR: FAN Yongnian [2868 3057 1628]

ORG: Institute of Metal Research, Academia Sinica

TITLE: "The Ordered Structure Formed on Mo (001) and Mo (110) Surfaces   by Bombardment of Nitrogen Ions"

TEXT OF ENGLISH ABSTRACT:

After bombarding the Mo(001) and Mo(110) surfaces contained trace amount of carbon and oxygen with nitrogen ions of the energy of 1 keV and the beam current of 6 μA for 10—15 min, a very strong Auger peak of nitrogen appeared in AES.

The LEED observation showed that surface structure was disordered from room temperature to 350°C annealing. When the sample was heated to the temperature range 530—650°C, three types of LEED pattern, i. e., c(2 × 2)-N, p(2 × 2)-N and $(4\sqrt{2} \times \sqrt{2})R45°$-N, O formed on Mo(001). In the case of Mo (110) only one type LEED pattern of c(7 × 3)-N was observed.

The fact that the LEED structure of the surface is related to thermal desorption indicates that ordered structure depends on coverage of nitrogen and temperature and provides some information about phase transformation on the surface.

12949
CSO: 4009/284

AUTHOR: YANG Yuan [2799 0626]
        YU Wenhai [0205 2429 3189]

ORG: Department of Physics, University of Science and Technology of China, Hefei

TITLE: "Study of the Conducting Behavior of an Amorphous Li^+ Conductor in the Isothermal Treatment Process"

TEXT OF ENGLISH ABSTRACT: The conducting behavior of an amorphous Li^+ conductor $B_2O_3-0.7Li_2O-0.7LiCl-0.1Al_2O_3$ has been measured continuously and automatically by using the a.c. Volt-Ampere method in the isothermal treatment process at a certain temperature below its transition temperature. It was found that the conductivities of the speciments increased at the initial stage and decreased monotonically after passing a maximum point, and then two flat steps appeared. Comparing these results with that obtained by DSC and XRD analysis, we confirmed that the presence of the maximum point of the conductivities is principally due to the amorphous phase separation, and the flat steps on the diagram of the conductivities are due to the amorphous crystallization. These results were discussed preliminarily in the view of the interface effects between different phases.

12949
CSO: 4009/285

AUTHOR: XU Yongnian [1776 3057 1628]
        XU Jianhua [1776 1696 5478]
        XIE Leiming [6200 7191 7686]

ORG: XU of the Institute of Modern Physics, Fudan University; XU and XIE of
the Shanghai Institute of Metallurgy, Academia Sinica

TITLE: "Band Structure of CoSi$_2$"

TEXT OF ENGLISH ABSTRACT: The band structure and the density of states of
CoSi2 were calculated by means of the self-consistent LMTO method.   The peak
positions of the calculated DOS were in reasonable agreement with the
corresponding peak positions of the synchrotron radiation photoemission
studies.   Our calculated results showed that the main characteristic of the
electronic structure of the silicides CoSi2 and NiSi2 were dominated by the
hybridization between the transition metal-3d orbitals and the silicon-3d
orbitals.   The bonding in CoSi2 and NiSi2 was different from that of bulk Si,
where the bonding was due to the sp3 hybridization of Si atom orbitals.

12949
CSO: 4009/285

AUTHOR: GU Biao [7357 1753]

ORG: Southwestern Institute of Physics, Leshan, Sichuan, China

TITLE: "Suppression of Cold Plasma Wavebreaking by Random Frequency Modulation"

TEXT OF ENGLISH ABSTRACT: In this paper, the Kubo-Anderson process has been adopted to describe the random frequency modulation of a driven field.   Its suppression effect on inhomogeneous cold plasma wavebreaking has been analyzed.   The expressions of wavebreaking time, fast electron energy and the average square of maximum localized electric field have been derived, which can be applied in any band width of the frequency modulation while the Bogoliubov's nonlinear frequency shift is not taken into account.   The agreement between the theoretical predictions and the experimental results is fair.   Thus we show that the random frequency modulation is an effective method to suppress the wavebreaking and fast electron energy.

12949
CSO: 4009/285

AUTHOR: ZHANG Yufeng [1728 3768 5762]
        WENG Shifu [5040 6108 3940]
        MENG Xiangti [1322 4382 2251]
        et al.

ORG: ZHANG of the Department of Physics, Beijing University; WENG of the
Department of Chemistry, Beijing University; MENG of the Institute of Energy
Technique, Xinhua University

TITLE: "Infrared Absorption of Neutron-Irradiated FZ-Si Grown in Hydrogen
Atmosphere"

TEXT OF ENGLISH ABSTRACT: Infrared absorption spectra of neutron irradiated
FZ-Si grown in hydrogen atmosphere have been measured in wave-number ranges
1800-2300 cm-1 and 400-1200 cm-1 by FTIR.   The annealing behavior of stronger
absorption bands has been shown. By comparing with spectral results of proton
implanted silicon measured by IR and neutron irradiated FZ-Si grown in
hydrogen atmosphere measured by DLTS, the possible constructions of H-related
centeres are discussed.

12949
CSO: 4009/285

AUTHOR: PU Huanshun [3450 3562 7311]
         ZHONG Yuanyuan [6988 0337 0377]
         JIANG Jianhua [5592 1696 5478]
         et al.

ORG: Institute of High Energy Physics, Academia Sinica

TITLE: "Preliminary Experimental Results of the β-Particle Detection with Superconducting Tunnel Junction Using D. C. Josephson Effect"

TEXT OF ENGLISH ABSTRACT: The detection of nuclear particles with superconducting tunnel junctions using the D.C. Josephson effect is expected to have the merits of good energy resolution and fast time response. It was the first time that such an experiment to detect Sr90-Y90 β-particles by the Nb-NbO$_x$-Pb superconducting tunnel junctions has been performed. The results showed that, under the β-particles irradiation, not only the critical current and energy gap voltage of the superconducting tunnel junctions increased, but the voltage pulse signals at both ends of the superconducting tunnel junctions were produced as well. In this paper some phenomena observed on β-particle detection with superconducting tunnel junctions using the D.C. Josephson effect are discussed.

12949
CSO: 4009/285

AUTHOR: LI Deping [2621 1795 1627]
          CHEN Mingjun [7115 2494 3537]

ORG: Institute for Radiation Protection, Ministry of Nuclear Industry

TITLE: "Safety Considerations in Design and Operation of Installations
Using Sealed Sources"

SOURCE: Taiyuan FUSHE FANGHU [RADIATION PROTECTION] in Chinese Vol 5 No 3,
1985 pp 161-168

TEXT OF ENGLISH ABSTRACT: In the development and application of nuclear
technology, it is necessary to pay sufficient attention to radiation safety
to prevent radiation accidents. In this article some principles and measures
which are important for the design and operation of installations with sealed
sources are discussed in detail. The design of safety features and the
quality of sources are strongly emphasized.

AUTHOR: XIA Yihua [1115 4135 5478]
          LIU Yulian [0491 3768 5571]
          JIN Ronghua [6855 2837 5478]
          et al.

ORG: Institute of Atomic Energy

TITLE: "Development of a Large Area Alpha Gridded Ionization Chamber"

TEXT OF ENGLISH ABSTRACT: A gridded ionization chamber with low background and large area (1500 cm^2) has been developed. It is filled with P_{10} gas of 1.8 atmospheres, and the capacity between its collector and ground is 20pF. Contributions from several main factors to spectrum width are: electronic noise--20 keV; ionization straggling--16 keV; grid inefficiency factor--11.3 keV; electron collection time variation--3.5 keV; self-absorption of sourch thickness--30 keV. The sum is approximately 41.2 keV.

The background is about 6.1 cph (4-6 MeV) and 0.1 cph (over spectral line width of 50 keV at 5 MeV). A newly developed zirconium oxide pump was used to clear negatively charges gases. Therefore, long-term stable work is ensured. The minimum detectable activity is $10^{-14} - 10^{-15}$ Ci.

AUTHOR: ZHAO Yamin [6392 0068 3046]
          ZHOU Hongjie [0719 3163 2638]
          ZHAO Guanghui [6392 0342 6540]

ORG: Institute for Application of Atomic Energy, Chinese Academy of
Agriculture Sciences

TITLE: "Monitoring and Protection of Contamination Caused by Tritium Targets
Used for Accelerator"

TEXT OF ENGLISH ABSTRACT: The surface and air contamination by tritium
targets used for an accelerator and the relase rate of tritium from the
target into the air have been determined. Experimental results show that
contamination at the area near the tritium target is very serious. However,
the contamination caused by tritium targets may be greatly reduced if the
targets are stored in a vacuum desiccator.

9717
CSO: 4009/278

AUTHOR: WANG Shouwu [3769 1343 2976]
           XIA Yongwei [1115 3057 0251]
           KONG Lingkun [1313 0109 0981]
           et al.

ORG: Institute of Semiconductors, Chinese Academy of Sciences

TITLE: "Thin Bulk Effects in SOI Structure"

SOURCE: Beijing BANDAOTI XUEBAO [CHINESE JOURNAL OF SEMICONDUCTORS] in
Chinese Vol 6 No 3, May 85 pp 225-235

TEXT OF ENGLISH ABSTRACT: The potential and carrier distribution in different
parts of an SOI [silicon on insulator] structure are studied by using computer
simulation. The results show that thin bulk effects occur in the SOI structure
with uniformly doped P-type recrystallization silicon film when the thickness
of the film is less than the maximum thickness of the depletion layer. The
higher the threshold voltage the thicker the recrystallization film when the
thickness of the inner dioxide is constant, whereas the lower the threshold
voltage the thicker the inner dioxide when the film thickness is constant.
The threshold voltage decreases as the inner dioxide thickness increases and
finally becomes a constant value not dependent on the thickness of inner
dioxide. The interface states with positive charges in the SOI structure
further decrease the threshold voltage. Simulation analysis shows that the
principle design rule to prevent thin bulk effects in an SOI structure is to
make the thickness of the recrystallization film exceed the maximum thickness
of the depletion layer, and to use low doping density silicon films and thick
inner dioxide so as to decrease the influence of thin bulk effects when the
film thickness is less than the maximum thickness of the depletion layer.
The simulation presupposes that it is possible to develop new MOS thin film
transistors with crystal silicon substrate and lower threshold voltage. The
simulation shows that the expression of threshold voltage for the SOI structure,
using depletion approximation, is very simple and more accurate.

AUTHOR: GAO Jilin [7559 1323 2651]
        WU Ronghan [0702 2837 3352]
        LI Zhaoyin [2621 3564 6892]
        et al.

ORG: Institute of Semiconductors, Chinese Academy of Sciences

TITLE: "Deep Levels in (Ga, Al)As/GaAs and GaInAsP/InP Lasers"

TEXT OF ENGLISH ABSTRACT: By using Deep Level Transient Spectroscopy (DLTS),
the deep levels in (Ga, Al)As/GaAs and GaInAsP/InP lasers with broad and proton-
bombarded stripe contacts have been detected. The laser wafers with four
layers are grown by the LPE technique. A preliminary discussion is given of
the laser degradation caused by these deep levels.

AUTHOR: CHEN Keming [7115 0344 6900]
          QIU Lanhua [0092 5695 5478]
          WANG Sen [3769 2773]
          CHEN Weide [7115 4850 1795]

ORG: Institute of Semiconductors, Chinese Academy of Sciences

TITLE: "Effects of Chemical Compositional Deviation with Respect to n-GaAs Surface on Performances of Schottky Barrier Diodes"

TEXT OF ENGLISH ABSTRACT: AES analysis is used to investigate the chemical compositional differences on the n-GaAs surface caused by different chemicals and C-V, I-V and G-V measurements are made on the main physical parameters of the Ni/n-GaAs Schottky diode formed by electroplating on n-GaAs surfaces with different chemical compositions and also made on interface state density and captured cross sections. Experimental results show that the chemical compositions on the n-GaAs surface have a direct influence on the height of the Schottky barrier, the interface gradient, the ideal factor, the saturated current density and carrier concentration profile in the neighborhood of the junction, etc. The optimum etching conditions are gained and a nearly ideal Schottky junction is obtained. In addition, it has been found that there are two kinds of interface states in the Ni/n-GaAs interface: one has a low interface state density, a larger capture cross section and a lower time constant, and the other has a high interface state density, a small captured cross section and a higher time constant. These are related to the performance of the Schottky barrier or Fermi-level pinning at the interface. However, the position of Fermi-level pinning at the interface of the above-mentioned three different Ni/n-GaAs is nearly the same as that in the bandgap.

157

AUTHOR: LI Yungang [2621 0061 1511]
          LIN Yu [2651 7183]

ORG: Institute of Semiconductors, Chinese Academy of Sciences

TITLE: "Research on Microprocessor Test Pattern Generation"

TEXT OF ENGLISH ABSTRACT: A new method of composing a microprocessor test
program, the T-classifying method, is proposed. This method has been used
for composing the 8080 µP test program, of which parts have been tested.
Compared with instruction function classifying, this method can save
78.5 percent of the content of the pattern memory, has better adaptability
and analyzes faults more easily.

Semi-automatic pattern generation on the MDR-Z80 microcomputer by establish-
ment of the standard pattern element storeroom has been realized. The
feasibility of fully automatic pattern generation is discussed.

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TITLE: "Stationary Domain Originating from Cathode Deep Recess Doping
Distribution in GaAs Transferred Electron Devices"

TEXT OF ENGLISH ABSTRACT: The effect of different cathode deep recess
doping distributions in GaAs transferred electron devices on the domain state
is discussed. It is pointed out that stationary domain is formed when the
cathode recess doping distribution is rather deep. The growth and features
of this kind of stationary domain are discussed.

AUTHOR: WANG Shouwu [3769 1343 2976]
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TITLE: "On the Rate Equation of the Photon Density in Semiconductor Lasers"

TEXT OF ENGLISH ABSTRACT: The rate equation of the photon density in semi-
conductor lasers usually does not include the coherent enhancement effect of
the Fabry-Perot resonator. This coherent enhancement effect has been
considered and a modified rate equation is obtained which is a nonlinear
differential equation of photon density. When the photon density in the
cavity is very low, the modified rate equation is essentially the same as
usual; when the photon density in the cavity is rather high, the modification
is not negligible.

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TITLE: "Determination of the Interfacial Fermi Level Position for Noble Metals on GaAs (110)"

TEXT OF ENGLISH ABSTRACT: The I-V method has been used to measure the barrier height of Schottky diodes for Cu, Ag and Au on GaAs (110) cleaved surfaces prepared in an ultrahigh vacuum, and soft X-ray photoelectron spectroscopy with synchrotron radiation has been carried out to determine the interfacial Fermi level position at the Cu-n-GaAs (110) interface. The results obtained by both methods are quite consistent. The interfacial Fermi level position for noble metals on n-type GaAs (110) is located at 0.9 ± 0.05 eV below the conduction band minimum, corresponding to the same value of the Schottky barrier height and to the donor level defined by the defect model.

161

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TITLE: "A Control Technology of Compositional Repeatability for the Growth of $In_{1-x}Ga_xAs$ Epilayers by LPE"

TEXT OF ENGLISH ABSTRACT: $In_{1-x}Ga_xAs$ ($x \simeq 0.47$) epilayers grown by LPE with gradual deduction in the starting growth temperature T_g have been investigated by use of Electron Probe Micro Zone Analysis and Cathodoluminescence. The results show that with this method the growth solution can be used many times repeatedly.

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ORG: Fudan University

TITLE: "Correlation Between Optical Absorption Coefficient at 10.6 μm and the Resistivity of Crystalline Silicon"

TEXT OF ENGLISH ABSTRACT: The correlation between the optical absorption coefficient at a wavelength of 10.6 μm and the corresponding electrical resistivity of single crystalline silicon is determined experimentally. The resulting calibration curves are considered to be applicable in the contactless and non-destructive characterization of silicon wafers for resistivity less than 1 Ω-cm and its radial profiles. The influence of surface roughness and high oxygen and carbon contents on the absorption-resistivity relationship has been observed and discussed.

AUTHOR: PAN Ji [3382 1213]
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          ZHAO Honglin [6392 7703 7792]
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ORG: Department of Electronical Engineering, Tianjin University

TITLE: "Correlation of Ar^+ Gettering Efficiency with Doses"

TEXT OF ENGLISH ABSTRACT: The removal of heavy metallic elements from the
active region of a silicon wafer has been studied through the implantation
of high energy Ar^+ into the backside of the wafer. The measurement of the
gettering effect is based on the measurements of the minority carrier's
lifetime. The experimental results show that the optimized doses are about
7.5×10^{14} cm^{-2} and 7.5×10^{15} cm^{-2}. Finally, the relationship between
gettering efficiency and residual defect density is mentioned.

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          ZHANG Nanping [1728 0589 1456]
          YU Guangming [0151 0342 2494]
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TITLE: "Effect of High Temperature Annealing on Crystallized Characteristics of GD a-Si$_x$C$_{1-x}$:H Films"

TEXT OF ENGLISH ABSTRACT: Experimental results show that when the annealing temperature is ~550°C, the crystallization of a-Si$_x$C$_{1-x}$:H is initiated and the size of the grain and crystallized region increases with the rise of the annealing temperature. The absorption coefficient, band gap and activation energy of these crystallized a-Si$_x$C$_{1-x}$:H films decrease while the dark conductivity increases.

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TITLE: "Determination of Hydrogen Content in a-Si Film by Gas Chromatographic Method"

TEXT OF ENGLISH ABSTRACT: For the first time, the total hydrogen content in an amorphous Si film and the hydrogen effusion rate from it at different temperatures are determined by gas chromatographic technology. This method is found to be more reliable than the pressure measurement adopted in the hydrogen effusion experiment.

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166